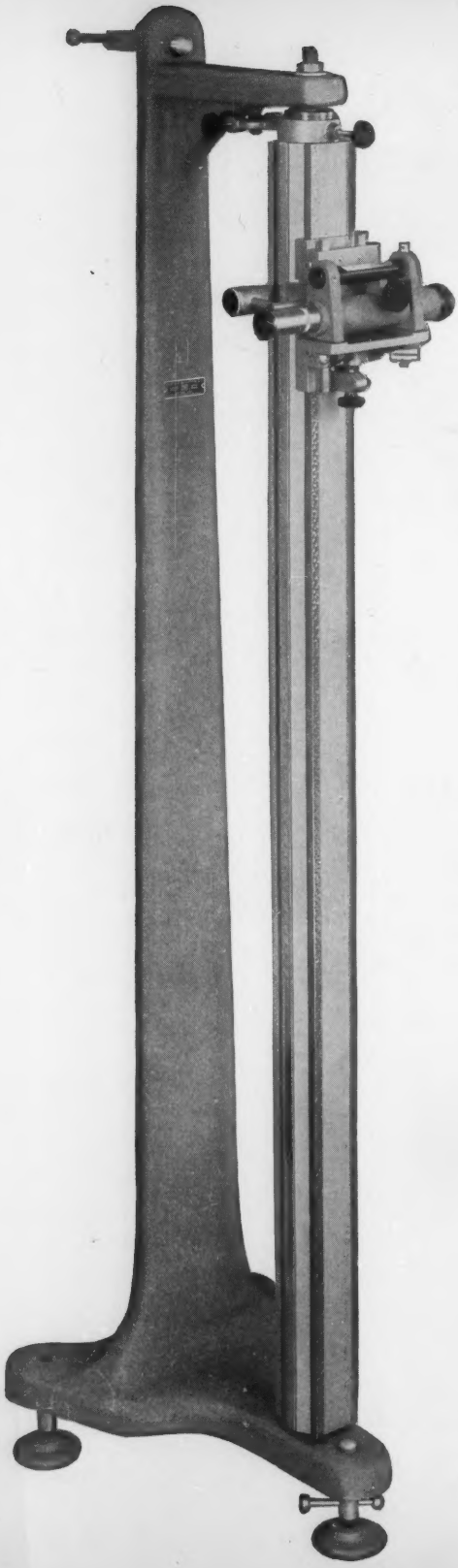
SCIENCE

20 September 1957

Volume 126, Number 3273

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE



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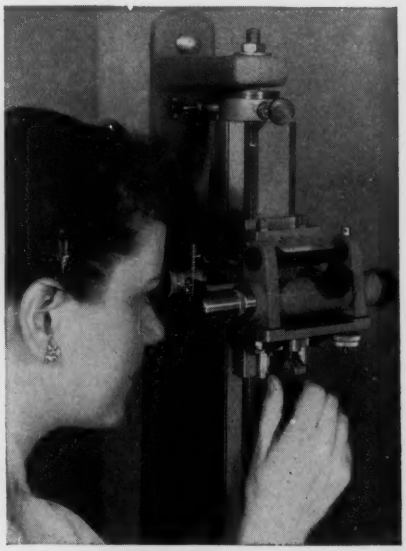

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SCIENCE is published weekly by the AAAS, 1515 Massachusetts Ave., NW, Washington 5, D.C. Entered at the Lancaster, Pa., Post Office as second class matter under the act of 3 March 1879. Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢.

YTTRIUM

Availability of high purity yttrium and rare earth oxides

A report by LINDSAY

Only three years ago, most high purity rare earths were little more than laboratory curiosities.

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TYPICAL MAXIMUM IMPURITIES IN LINDSAY PURIFIED RARE EARTH AND YTTRIUM OXIDES

ATOMIC NO.	OXIDE	CODE	PURITY	% RARE EARTH MAXIMUM IMPURITIES AS OXIDES
57	La_2O_3. LANTHANUM OXIDE	528	99.99	0.01 Pr, 0.001 Ce.
		529	99.997	0.0025 Pr, 0.0005 others
58	CeO_2. CERIC OXIDE	215	99.8	0.2 (largely La + Pr + Nd).
		216	99.9	0.1 (largely La + Pr + Nd).
59	Pr_6O_{11}. PRASEODYMIUM OXIDE	726	99	1 La + Nd + smaller amounts of Ce and Sm.
		729.9	99.9	0.1 Ce + Nd.
60	Nd_2O_3. NEODYMIUM OXIDE	628	95	1-4 Pr, 1-4 Sm, 0.5-1 others.
		629	99	0.1-0.4 Pr + 0.1-0.4 Sm + 0.5 others.
		629.9	99.9	0.1 (largely Pr + Sm).
62	Sm_2O_3. SAMARIUM OXIDE	822	99	0.2-0.7 Gd, 0.2-0.6 Eu, and smaller amounts of others.
		823	99.9	0.1 (largely Nd + Gd + Eu).
63	Eu_2O_3. EUROPIUM OXIDE	1012	98-99	1-2 Sm + smaller amounts of Nd + Gd + others.
		1011	99.8	0.2 (largely Sm + Gd + Nd).
64	Gd_2O_3. GADOLINIUM OXIDE	928.9	99	1 Sm + Eu + trace Tb.
		929.9	99.9	0.1 Sm + Eu + trace Tb.
65	Tb_4O_7. TERBIUM OXIDE	1803	99	1 Gd + Dy + Y.
		1805	99.9	0.1 Gd + Dy + Y.
66	Dy_2O_3. DYSPROSIUM OXIDE	1703	99	1 (largely Ho + Y + Tb + small amounts of others).
		1705	99.9	0.1 Ho + Y + traces of others.
67	Ho_2O_3. HOLMIUM OXIDE	1603	99	1 (largely Er + Dy + small amounts of others).
		1605	99.9	0.1 Er + Dy + traces of others.
68	Er_2O_3. ERBIUM OXIDE	1303	99	1 Ho + Dy + traces Yb and Y.
		1305	99.9	0.1 Ho + Tm.
69	Tm_2O_3. THULIUM OXIDE	1405	99.9	0.1 Er + Yb + trace Lu.
		1403	99	1 Er + Yb + trace Lu
70	Yb_2O_3. YTTERBIUM OXIDE	1201	99	1 Er + Tm + trace Lu.
		1202	99.9	0.1 Tm + trace Lu + Er.
71	Lu_2O_3. LUTETIUM OXIDE	1503	99	1 Yb + Tm + traces of others.
		1505	99.9	0.1 Yb + Tm + traces of others.
39	Y_2O_3. YTTRIUM OXIDE	1112	99	1 Dy + Gd + traces Tb and others.
		1115	99.9	0.1 Dy + Gd + traces Tb
		1116	99.9+	Approx. 0.05 Dy + Gd.

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20 September 1957, Volume 126, Number 3273

SCIENCE

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of 3 March 1879.

SCIENCE is indexed in the *Reader's Guide to Periodical Literature* and in the *Industrial Arts Index*.

Editorial and personnel-placement correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D.C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors. For detailed suggestions on the preparation of manuscripts, book reviews, and illustrations, see *Science* **125**, 16 (4 Jan. 1957).

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Annual subscriptions: $7.50; foreign postage, $1; Canadian postage, 50¢. Single copies, 25¢. Special rates to members of the AAAS. Cable address: Advancesci, Washington.

Rates effective 1 January 1958: $8.50; foreign postage, $1.50; Canadian postage, 75¢. Single copies, 25¢.

National Science Youth Month

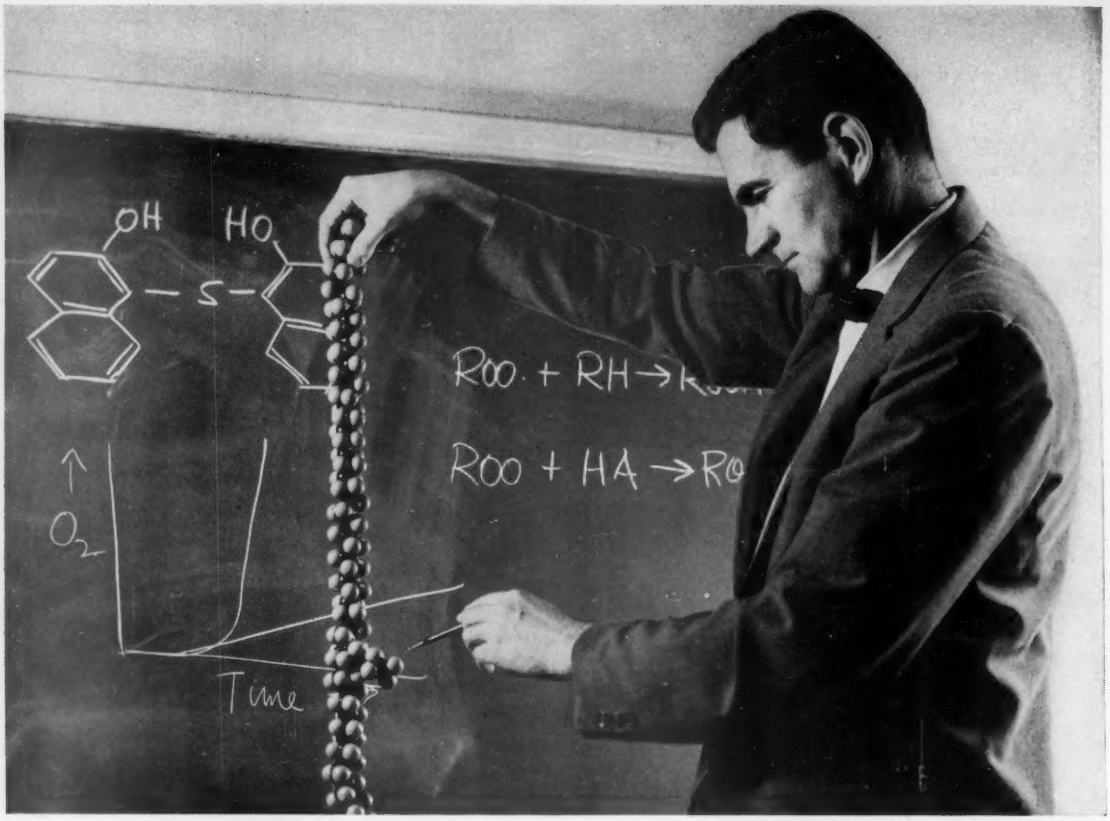
In his very funny *Whizz for Atomms*, Geoffrey Willans confronts us with a half-literate but irrepressible British schoolboy, Nigel Molesworth, whose bright dreams of glory ("It is the Peason-molesworth Atommic Pile fitted with radio and plug for electric razor") are in grim contrast with school life as he sees it (". . . enter sigismund the mad maths master—SIGISMUND [to pupils]: Come on get cracking no talking no smoking . . . you are in my clutches agane"). Although Molesworth, no doubt, poses an insoluble problem to education, it is possible in some cases to make a lively imagination ease, rather than increase, the burden of learning. What is necessary is somehow to lead boys and girls into the discovery that, for those who can do it, intellectual effort is a form of bold adventure.

This principle is the basis for a group of local and country-wide programs that have developed during the past 15 or 20 years with the purpose of locating bright youngsters and making of them students of science. The programs encourage boys and girls to embark on scientific or technical projects suitable to their age—for example, to demonstrate known natural laws by experiments of their own design or to observe known phenomena through instruments of their own construction. In addition, by arranging public activities in the form of science fairs and junior academies of science, the programs bring like-minded youngsters together and give members of the community in which they live an opportunity to learn of their achievements.

To emphasize the programs planned for the new school year, the President's Committee on Scientists and Engineers has designated October as National Science Youth Month. Although the activities are varied, contact with students is usually through local science clubs, which may be set up as an extracurricular activity in a school and which may have a school teacher as the adult sponsor. Several national organizations, among which is the AAAS, advise and coordinate local efforts. The science fairs may be held in museums, school gyms, or school auditoriums, with the winning projects competing at the end of the year in a National Science Fair. The junior academies of science, in which papers are read or talks are given by guest speakers, may be run in connection with state or city academies of science.

One of the best known programs is the Science Talent Search, designed for high-school seniors who are already well on their way to a scientific education. Supported financially by the Westinghouse Educational Foundation and administered by Science Service, it awards each year substantial scholarships and other prizes. Last year's three top entries were by two boys and a girl, who submitted reports titled, respectively, "Automatic cloud chamber," "Use of vapor pressure measurements for analysis of ideal solutions," and "Effects of colchine on *Drosophila*."

As with most human action, the persons and organizations who sponsor the different programs may do so for several reasons. Perhaps some act out of a conviction that scientific activity is one of the goods of life, and perhaps others because science is so important to the national defense and common security. It may well be that during the coming school year some *Science* readers will be asked to help out at a club, fair, or junior academy. For information about the many agencies cooperating in National Science Youth Month, write to Science Service, 1719 N Street, NW, Washington 6, D.C.—J.T



Bell Laboratories chemist Field H. Winslow, Ph.D., Cornell University, with a scale model of a small section of a polyethylene molecule. Branch formation indicated by pencil is vulnerable to oxidation. Dr. Winslow and his associates worked out a simple way to protect long polyethylene molecules needed for durable cable sheathing.

THE DILEMMA OF GIANT MOLECULES

Solution: 2 plus 2 equals 5

Polyethylene is used to protect thousands of miles of telephone cables. It is tough, light and long lasting. Its strength lies in its giant molecules—a thousand times bigger, for example, than those of its brittle chemical cousin, paraffin wax.

But polyethylene has a powerful enemy: oxidation, energized by light and heat, shatters its huge molecules to pieces. This enemy had to be conquered if polyethylene was to meet the rigorous demands of cable sheathing. Paradoxically, it was done by making the whole better than the sum of its parts—just as though 2 plus 2 could be made to add up to 5.

To check the ravages of light, Bell Laboratories chemists devised the simple yet highly effective remedy of adding a tiny dose of carbon black. Then antioxidants, such as those commonly used to protect rubber, were added to check attack by heat. But here the chemists encountered a dilemma: although the carbon black protected against the effects of light, it critically weakened the effectiveness of the antioxidants.

To solve this dilemma, Bell Labs chemists developed entirely new types of antioxidants—compounds not weakened by carbon black but which, intriguingly, are very much more effective when carbon black is present. The new antioxidants, plus carbon black, in partnership, provide long-lasting cable sheath—another example of how research at Bell Telephone Laboratories works to improve your telephone service.

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WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

20 September 1957, Volume 126, Number 3273 SCIENCE

Radioactivity of Potassium and Geologic Time

G. W. Wetherill

During the past few years, considerable attention has been given to the possibility of dating minerals by the decay of potassium into argon. The two principal problems involved have been the uncertainties in the radioactive decay constants of potassium and in the ability of minerals to retain the argon produced by this decay. In this article the current status of these problems is reviewed, and the results of new investigations into them are reported.

The emission of beta particles by potassium was discovered by J. J. Thomson in 1905 (*1*). In 1928 Köhlhorster (*2*) observed gamma radiation as well. The subsequent growth of nuclear theory led Klemperer (*3*) and Newman and Walke (*4*) to predict that the radioactivity should be assigned to an unknown isotope of potassium, probably of mass 40. This isotope was discovered by Nier (*5*) in 1935.

In 1937, C. F. von Weiszäcker (*6*) pointed out that K^{40} should also be expected to decay by orbital electron capture to A^{40}, and noted that this would explain the anomalously high abundance of A^{40} in the atmosphere. He also predicted that old minerals containing potassium should contain highly radiogenic argon. The existence of radiogenic argon in potassium minerals was actually demonstrated by Aldrich and Nier in 1948 (*7*), thus proving conclusively the decay of potassium to argon. Subsequent counting experiments by Sawyer and Wiedenbeck (*8, 9*) and mass measurements by Johnson (*10*) have established the decay scheme shown in Fig. 1.

The possibility still exists that there is a small amount of electron capture directly to the ground state of A^{40}. By combining the limits set by Bell and Cassidy (*11*) in a search for positron activity from K^{40} with theoretical values for the positron-to-electron capture ratio given by Fireman (*12*), it can be calculated that less than 10 percent of the decay is directly to the ground state. By use of the nuclear matrix elements for the similar beta decay of A^{40} to Ca^{40}, together with the theory of electron capture as given by Major and Biedenharn (*13*), the fraction of the electron capture going directly to the ground state of A^{40} has been estimated to be 5 percent. However, the uncertainties in this calculation are such that the value could be in error at least an order of magnitude. Thus, there is no definitive evidence on this question at the present time. If it is assumed that the rate of electron capture directly to the ground state of A^{40} is negligible, then the measurement of the specific gamma activity will give the rate of electron capture. This assumption is made in this article.

Measurement of Mineral Ages by the Potassium-Argon Method

The potassium-argon age of a mineral is related to its radiogenic argon content through the relationship

$$t = \frac{1}{\lambda_e + \lambda_\beta} \ln \left(1 + \frac{\lambda_e + \lambda_\beta}{\lambda_e} \frac{A^{40}}{K^{40}} \right)$$

where A^{40} is the concentration of radiogenic argon; K^{40} is the concentration of potassium-40; λ_e is the decay constant for electron capture to A^{40}; and λ_β is the decay constant for beta decay to Ca^{40}.

Partial differentiation of this equation with respect to λ_e and λ_β shows that the error in the calculated age of a mineral is much more sensitive to an erroneous value of λ_e than it is to a comparable error in λ_β, as has been discussed previously (*14*). As a result of this fact, the present experimental uncertainty in the value of λ_β (about 10 percent) does not result in any serious uncertainty in the potassium-argon age calculations, while the range of experimental values of λ_e (about 30 percent) is quite serious. It should also be noted that λ_e enters into the equation in three places, once outside the logarithmic expression and twice inside. However, since λ_e is of the order of $0.1\lambda_\beta$, the calculated age is sensitive to λ_e only where it occurs alone in the denominator of the logarithmic expression. Here it occurs as a product $\lambda_e \cdot K^{40}$, so if the specific gamma activity of *natural* potassium is determined experimentally, the value of this product will not be affected by any uncertainty in the isotopic abundance of K^{40} in natural potassium.

A principal difficulty in the application of the potassium-argon method has been the uncertainty in the value of the specific gamma activity. A summary of the experimental values for the specific gamma and beta activities is given in Table 1. These values scatter widely. The other major uncertainty has been the fraction of argon which has been retained by the mineral during the time since its formation. Although it has proved to be difficult to answer both of these questions by measurements with minerals, some conclusions can be drawn from comparisons of potassium-argon ages with ages obtained by other methods (*14*). Briefly, these are that the specific gamma activity is greater than 3.2 gammas per gram, per second, and that feldspars have lost up to half of their argon during the time since their formation. On the other hand, mica seems to retain nearly all its argon. However, it has been shown by Wasserburg (*15*) that it is very difficult to distinguish between an erroneous value of λ_e and a small amount of argon loss. Therefore a definitive answer to the problem of the decay constant and the argon retentivity requires an accurate laboratory determination of the specific gamma activity.

The author is a staff member at the department of terrestrial magnetism, Carnegie Institution of Washington, Washington, D.C.

Measurement of Specific Gamma Activity

Most previous determinations of the specific gamma activity have made use of counting techniques which did not distinguish between the ionization produced by the gamma ray itself and other sources of ionizing radiation. Since K^{40} has a single gamma ray, and since accurate corrections can be made for interfering phenomena such as bremsstrahlung and background, this has not been a serious limitation in the counting of this particular gamma ray. However, it is always necessary to know the efficiency of the counter for gamma rays of this energy (1.46 Mev), and this requires calibrating the counter with gamma rays from sources of known specific activity.

Unfortunately, all the standard sources for this energy either have more than one gamma ray in their spectrum or involve an uncertainty in the fraction of the disintegration which involves the emission of the standard gamma ray. For example, Sawyer and Wiedenbeck (*8*) used K^{42} for a standard, using a source of known absolute beta activity and mixing the radioisotope with the potassium chloride that was used for the counting of natural potassium. The energy of the K^{42} gamma ray is almost the same as that of K^{40}, and since K^{42} was mixed with the potassium chloride, all errors owing to self-absorption, scattering, and geometrical uncertainties are eliminated. Sawyer and Wiedenbeck assumed that the 1.49-Mev gamma ray occurs in 25 percent of the K^{42} decays. However, this value has little experimental support, and, in view of the wide range of values found for this quantity (*16*), the uncertainty in the specific gamma activity of a K^{42} source is as great as the uncertainty in the specific gamma activity of natural potassium and thus is hardly suitable for use as a standard.

Other workers—for example, Suttle and Libby (*17*)—have used cobalt-60 as a standard. However, here there are two gamma rays, and the efficiency calculated will be that of some average energy intermediate between the gamma ray energies of 1.17 Mev and 1.33 Mev. Then it is necessary to extrapolate the efficiency at this uncertain energy to the energy of the potassium gamma ray, 1.46 Mev.

The difficulties involved in the use of sodium-24 are even greater, for the two gamma rays are widely separated in energy, 1.38 and 2.76 Mev. Difficulties of this sort are sufficiently serious to account for the wide spread in experimental values shown in Table 1.

Recently McNair, Glover, and Wilson (*18*) have reported a measurement of the specific gamma activity of natural potassium which eliminates some of these difficulties by use of a thallium-activated sodium iodide scintillation spectrometer which permitted them to use sodium-24 as a standard since they could single out those counts caused by the 1.38-Mev gamma ray. They obtained a value of the specific gamma activity of 3.33 gammas per gram, per second, which is about 3 percent higher than the value determined from the radiogenic argon content of mica (*14*). Although this experiment is superior to previous ones, there are still two possible objections which may be raised against it. The first is the necessity of guessing the difference in the efficiencies of the counter at 1.38 and 1.46 Mev. The second is that the calculated value for the specific gamma activity depends on their measurement of the specific beta activity of natural potassium, which is also a somewhat difficult experiment. This arises from the fact that their experiment was designed to determine the branching ratio λ_e/λ_β rather than λ_e itself.

In order to eliminate these difficulties, the present experiment makes use of Co^{60} as well as Na^{24}, thus determining the efficiency of the system at 1.17, 1.33, and 1.38 Mev. This permits a measurement of the variation of the efficiency with energy as well as the determination of the absolute efficiency at one energy. In addition, the absolute activity of the Co^{60} and Na^{24} sources themselves was known. The Co^{60} and Na^{24} standard solutions were obtained from the National Bureau of Standards. The Na^{24} solution had been standardized by absolute 2π beta counting as well as with a 4π gamma ionization chamber previously calibrated by $4\pi_\beta$ proportional counting. The Co^{60} standard had been compared with a primary cobalt solution in a 4π gamma ionization cham-

Table 1. Determinations of the specific gamma and beta activity of natural potassium.

Investigators	Activity	
	γ/g sec	β/g sec
Gleditsch and Graf (*24*)	3.6 ± 0.8	
Graf (*26*)		26.8 ± 1.2
Ahrens and Evans (*27*)	3.42 ± 0.07*	
Hess and Roll (*28*)	2.6	
Stout (*29*)		30.6 ± 2.0
Sawyer and Wiedenbeck (*8*)	2.88 ± 0.3†	
Spiers (*30*)	2.97	30.5
Faust (*31*)	3.6 ± 0.4	31.2 ± 3.0
Graf (*32*)	3.4 ± 0.5	
Houtermans, Haxel, and Heintze (*33*)	3.1 ± 0.3	27.1 ± 1.5
Smaller, May, and Freedman (*34*)		22.5 ± 0.7
Sawyer and Wiedenbeck (*9*)		28.3 ± 1.0
Good (*35*)		27.1 ± 0.6
Delaney (*36*)		32.0 ± 3
Burch (*37*)	3.37 ± 0.09	
Suttle and Libby (*17*)	2.96 ± 0.3	29.6 ± 0.7
Backenstoss and Goebel (*38*)	3.50 ± 0.14	
McNair, Glover and Wilson (*18*)	3.33 ± 0.15‡	
This article	3.39 ± 0.12	

* Recalculated using $E_\gamma = 1.46$ Mev.
† Recalculated using $\lambda_\gamma/\lambda_\beta = 0.20$ for K^{40}.
‡ Recalculated using their $\lambda_\beta/\lambda_\beta = 0.121$ and their specific beta activity of 27.5/g sec.

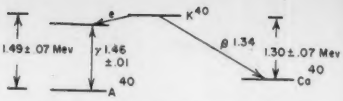

Fig. 1. Potassium-40 decay scheme.

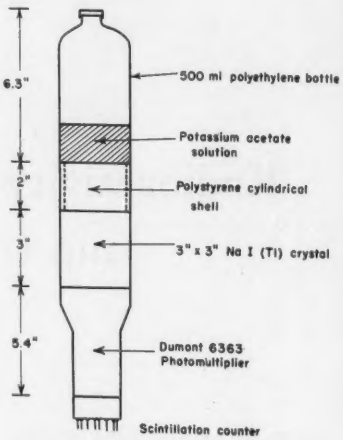

Fig. 2. Counting apparatus.

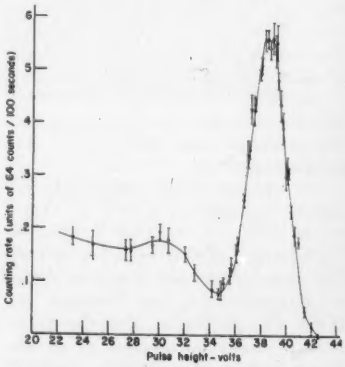

Fig. 3. Potassium-40 gamma-ray spectrum.

ber. The primary cobalt solution had been standardized by 4π beta counting, beta-gamma coincidence counting, and gamma-gamma coincidence counting. Since these sources had high specific activities, more accurate beta counting techniques could be employed than could be used to count the K^{40} beta particle, as was done by McNair, Glover, and Wilson.

Figure 2 is a diagram of the counting apparatus. Reagent-grade potassium acetate (1198 grams) was dissolved in water to a combined weight of 1694 grams. The potassium concentration of this solution was checked by mass spectrometric isotope-dilution analysis and it agreed with the gravimetric value within 1.5 percent. Two hundred and forty-two grams of this solution was poured into the polyethylene counting bottle, which was then placed above the 3- by 3-inch NaI (T1) crystal (Fig. 2). The counting bottle was held 2 inches above the crystal by a polystyrene support. This reduced the efficiency of the counter by a factor of approximately 2, and thus reduced undesirable effects owing to coincidences by a factor of 4. The entire apparatus was surrounded by a lead shield 3 inches thick. A single-channel pulse-height analyzer was used to obtain the spectrum shown in Fig. 3.

The peak in the spectrum is known as the "photopeak" and represents all those 1.46-Mev gamma rays which lose all of their energy in the crystal. The 1.46-Mev gamma ray was then counted by setting the bias of the pulse-height analyzer so that all pulses of higher voltage than the minimum (35.3 v) were counted. The background was determined in the same way, but with water instead of potassium acetate in the counting bottle. (The same background was found even when the counting bottle was removed). The stability of the pulse-height analyzer was checked periodically using standard gamma ray sources, and errors in the integrated photopeak count owing to drift in the bias were found to be negligible. The results of this counting are shown in Table 2.

Table 2. Potassium counting data (1 unit = 64 counts per 100 seconds).

Item	Data
Integral counting rate of potassium acetate soln. > 35.3 v	4.425 ± 0.01 units
Less background	2.205
Difference	2.22 units
Correction: photopeak < 35.3 v	+0.04
Total photopeak	2.26 ± 0.02 units
Wt. of K in potassium acetate soln.	68.3 g
Specific activity of soln.	0.0212 count/sec g of K
Efficiency (determined from Fig. 6)	0.625 ± 0.020 %
Specific activity of natural K	3.39 ± 0.12 γ/g sec

Table 3. Sodium-24 counting data (half-life = 14.96 hours; activity = 10,900 ± 2 percent disintegrations per second; 1 unit = 64 counts per 100 seconds).

Item	Correction (units)	Data
Integral count > 35 v		134.18 ± 0.2 units
Less potassium + background		4.63 ± 0.1
Difference		129.55 ± 0.2 units
Counting rate corrected for decay		337.5 ± 0.2 units
Integral count > 40 v		87.28 ± 0.3 units
Less potassium + background		3.37 ± 0.2
Difference		83.81 ± 0.4 units
Counting rate corrected for decay		223.4 ± 0.4 units
Counting rate 35 to 40 v		114.1 ± 0.5 units
Corrections		
Uncounted photopeak < 35 v	$+6.9 \pm 0.4$	
Uncounted photopeak > 40 v	$+4.9 \pm 0.4$	
Compton tail from 2.75-Mev γ	-15.3 ± 1.2	
Net correction		-3.5 ± 1.3 units
Net photopeak		110.6 ± 1.4 units
Correction factor for counts lost because of coincidences between 1.38- and 2.75-Mev gammas		1.007
Photo efficiency [(110.6/10,900) × 0.64 × 1.007]		0.653 ± 0.015%

The efficiency of the counter was measured by mixing standard Na^{24} and Co^{60} sources of relatively high specific activity with the potassium acetate. The spectra obtained with these sources are shown in Figs. 4 and 5, after subtraction of small contributions caused by background and potassium acetate.

The Na^{24} spectrum is relatively simple; the only complication is the contribution of the low-energy tail of the 2.76 Mev peak, which can be evaluated by measurement of the residual counting rate at the minimum of the 1.38-Mev photopeak and just above the 1.38-Mev photopeak. The "photoefficiency" of the 1.38-Mev gamma ray is determined by the difference between integral counts above 35 volts and integral counting above 40 volts and then by applying corrections, as shown in Table 3. It should be emphasized that the calculation of the photoefficiency does not depend in first order on the experimental determination of the gamma ray spectrum (Fig. 4) but depends on the integral counting rates.

The Co^{60} spectrum (Fig. 5) is more complex because of the two gamma rays (1.17 Mev and 1.33 Mev) which are incompletely resolved. However, it was possible to employ the same techniques in this case. Integral counts were taken above 34 and 40 volts for the 1.33-Mev peaks and above 28 volts and 34 volts for the 1.17-Mev peak. The portion of the 1.33-Mev peak which lay below 34 volts was determined by assuming that the 1.33-Mev Co^{60} peak has the same shape as the 1.38-Mev Na^{24} peak. Subtracting out the 1.33-Mev peak found in this way from the measured Co^{60} spectrum gives the 1.17-Mev peak. A check is provided by comparing the calculated 1.17-Mev Co^{60} peak with the photopeak of the 1.12-Mev gamma ray from zinc-65. The shapes of the two peaks were identical within experimental errors. The measured counting rates, together with the corrections, are shown in Table 4.

The calculated efficiencies at the three energies 1.17, 1.33, and 1.38 Mev are plotted in Fig. 6. The curve through these three points is extrapolated to 1.46 Mev, and the efficiency at this energy is found to be 0.625 ± 0.020 percent. If the

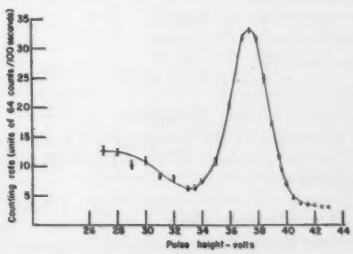

Fig. 4. Sodium-24 gamma-ray spectrum.

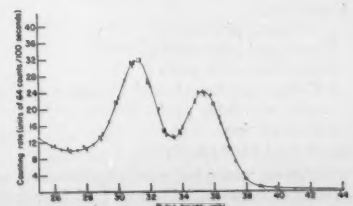

Fig. 5. Cobalt-60 gamma-ray spectrum.

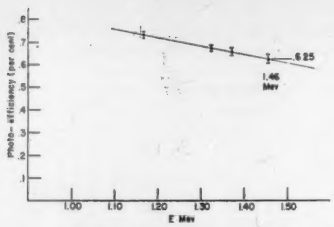

Fig. 6. Photoefficiency of NaI (Tl) crystal versus energy.

true efficiency lies outside these limits, it would require a sudden change in the efficiency-versus-energy curve. Since the fundamental processes for the interaction of gamma rays with matter vary continuously with energy, and since the curve depends on these fundamental processes in a complex way, such a sudden change would not be expected. By use of the efficiency found in this way, together with the counting rate shown in Table 1, the specific gamma activity of natural potassium was found to be 3.39 ± 0.12 gammas per gram, per second.

This result is in agreement with the result of McNair, Glover, and Wilson (*18*) (3.33 ± 0.15 gammas per gram, per second) and is about 4 percent higher than the result obtained by measurement of the radiogenic argon content of mica samples of known age (*14*).

Retention of Argon by Minerals

Using this value of the specific gamma activity, and assuming that electron capture directly to the ground state is negligible, the measurements on geologic materials may be used to evaluate the extent to which minerals have been able to retain radiogenic argon during geologic time. As has been discussed previously (*14, 19*), the most reliable absolute ages are those based on pegmatitic uraninite giving concordant uranium-lead ages—that is, the age calculated from the ratio Pb^{206}/U^{238} agrees with the age calculated from the ratio Pb^{207}/U^{235}.

Wasserburg and Hayden (*14, 20, 21*) and workers at this laboratory (*14, 19*) have published the results of measurements of concordant uranium-lead ages together with potassium-argon measurements from cogenetic mica and feldspar. Since the age of the mineral is known, the fraction of radiogenic argon retained can be calculated. The results of these calculations are shown in Table 5. From the data presented in Table 5, it may be concluded that the retentivity of feldspar is almost always low, whereas in most cases that of mica is greater than 90 percent. In fact, when the uncertainties in the comparison ages, the potassium-argon measurements, and the specific gamma activity are considered, there is no definitive evidence that most micas have lost any argon at all. However, it seems probable that they usually lose a small percentage of their argon, and occasionally as much as 20 percent. It has been shown that reliable ages are usually obtained by the rubidium-strontium method (*22*). A comparison be-

Table 4. Cobalt-60 counting data (activity = 8550 ± 1 percent disintegrations per second; 1 unit = 64 counts per 100 seconds.

Item	Correction (unit)	Data
A. 1.33-Mev peak		
Integral count > 34 v		89.3 units
Less integral count > 40 v		8.8
Counting rate 34 to 40 v		80.5 units
Less background + potassium		2.1
Difference		78.4 ± 0.5 units
Corrections:		
Uncounted photopeak > 40 v	+ 0.2 ± 0.2	
Uncounted photopeak < 34 v	+ 11.9 ± 0.6	
Coincidences 34 to 40 v	− 2.6 ± 0.3	
1.17-Mev photopeak under 1.33-Mev peak	− 1.3 ± 0.3	
Net correction		+ 8.2 ± 0.8 units
Total 1.33-Mev photopeak		86.6 ± 1.0 units
Correction factor for counts lost because of coincidences between 1.17- and 1.33-Mev gammas		1.030
Efficiency		0.668 ± 0.013 %
B. 1.17-Mev peak		
Integral count > 28 v		209.9 units
Less integral count > 34 v		89.3
Counting rate 34 to 40 v		120.6
Less background + potassium		1.4
Difference		119.2 ± 1.0 units
Corrections:		
Uncounted photopeak > 34 v	+ 1.3 ± 0.3	
Uncounted photopeak < 28 v	+ 2.9 ± 0.3	
Coincidences 28 to 34 v	− 1.9 ± 0.3	
1.17-Mev photopeak and Compton spectrum under 1.17-Mev peak	− 27.3 ± 0.8	
Net correction		− 25.0 ± 0.9 units
Total 1.17-Mev photopeak		94.2 ± 1.4 units
Correction factor for counts lost because of coincidences between 1.17- and 1.33-Mev gammas		1.030
Efficiency		0.727 ± 0.015 %

Table 5. Retention of argon by minerals as indicated by comparison with concordant uraninite ages (using specific gamma activity of 3.39 gammas per gram, per second, and specific beta activity of 27.6 betas per gram, per second). Bibliographic references are shown in parentheses in column 1.

Sample	Concordant uranium age (10^6 yr)	Argon retentivity (%)
Micas		
Portland, Conn. (*21*)	267	0.95
Glastonbury, Conn. (*21*)	255	0.97
Spruce Pine, N.C. (*14*)	375	0.88
Branchville, Conn. (*21*)	367	0.99
Parry Sound, Ontario (*21*)	994	0.93
Cardiff Township, Ontario (*14*)	1020	0.92
Wilberforce, Ontario (*14*)	1030	0.87
Keystone, S.D., lepidolite (*19*)	1600	0.81
Keystone, S.D., muscovite (*19*)	1600	0.95
Viking Lake, Saskatchewan (*14*)	1890	0.93
Bikita, Southern Rhodesia (*14*)	2650	0.80
Feldspars		
Portland, Conn. (*21*)	267	0.77
Glastonbury, Conn. (*21*)	255	0.81
New Bedford, N.Y. (*21*)	355	0.77
Branchville, Conn. (*21*)	367	0.75
Parry Sound, Ontario, microcline 1 (*21*)	994	0.72
Parry Sound, Ontario, microcline 2 (*21*)	994	0.78
Parry Sound, Ontario, albite (*21*)	994	0.60
Cardiff Township, Ontario, sample 1 (*22*)	1010	0.81
Cardiff Township, Ontario, sample 2 (*22*)	1010	0.76
Wilberforce, Ontaria (*14*)	1030	0.77
Tory Hill, Ontario, pegmatite (*22*)	1030	0.68
Tory Hill, Ontario, granite (*22*)	1030	0.68
Keystone, S.D., (*19*)	1600	0.59
Viking Lake, Saskatchewan (*22*)	1890	0.79

tween rubidium-strontium and potassium-argon ages gives retentivities similar to those shown in Table 4.

In view of the fact that fairly low retentivities sometimes occur even in the case of mica, measurement of the potassium-argon age of a mica does not give a completely trustworthy value of the age. A much safer criterion for the absolute age of a sample of mica is agreement between the potassium-argon and rubidium-strontium ages. Since the daughter products, argon and strontium, have such different chemical properties, any alteration of the mineral may be expected to cause these ages to diverge. When they agree, except perhaps for a 5- to 10-percent discrepancy caused by a small loss of argon, this age is almost certainly the true age of the mineral.

There are a great many other minerals, such as the amphiboles, which contain small quantities of potassium. With modern mass spectrometric isotope-dilution and high-vacuum technique, the radiogenic argon content of these minerals should be measurable. Some work has already been done on certain sedimentary minerals, in particular glauconite (*20, 23*). The retentivity of these minerals has not yet been evaluated, and it may well be that minerals will be found which are more retentive than the micas.

The causes of the low retentivity of most feldspars and some samples of mica have not been studied as yet; they offer an interesting field for research. A number of possibilities come to mind, such as diffusion, exsolution of albite in the case of the feldspars, and slight changes in crystal structure under changing conditions of temperature and pressure. It is possible that, eventually, the radiogenic argon content of minerals which have lost argon will provide geologically useful information. However, much careful work will have to be done before this will be possible.

Using existing techniques of potassium-argon age determinations combined with rubidium-strontium age measurements, it is possible at the present time to date the time of formation of mica in a great many igneous and metamorphic rocks. This is a very exciting immediate application, and it should be possible to discern the location in space and time of the major orogenic episodes in earth history. Important contributions of this sort may be expected in the next few years, and while the problems of Precambrian geology will probably continue to be overwhelming for some time to come, a significant new approach is being made to problems left unanswered by traditional geologic techniques (*24, 25*).

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25. I wish to thank G. M. Temmer and N. P. Heydenburg for helpful discussions and for use of much of the apparatus used in this work, as well as L. T. Aldrich and J. B. Doak for aid in construction of the scintillation counter. I also wish to thank H. H. Seliger of the National Bureau of Standards, who generously provided the calibrated standard solutions.

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Magnitude of Biological Hazard from Strontium-90

H. B. Newcombe

There are three main hazards to peacetime populations from radiation and radioactive materials, if we exclude major catastrophes and individual accidents. These are (i) the bone tumors (and possibly leukemias as well) which can result from ingestion of strontium-90, (ii) the shortening of the life span which results from exposure of the whole body to penetrating radiation (attributable in part to malignant diseases such as leukemia, and in part to a seemingly nonspecific acceleration of the aging processes), and (iii) the hereditary changes induced by radiation in the reproductive tissues.

In the case of i and ii, there are numerical estimates of the hazard. Thus, the extent of the loss of life expectancy caused by a given exposure can be estimated from animal data, supported to a limited extent by observations on human beings (*1*). Similarly, the probable numbers of future individuals who will suffer from serious hereditary defects as the result of a given radiation exposure can be derived from observations on the natural incidence of these defects and from estimates of the radiation dose required to double the spontaneous mutation rate in man (*1, 2*). In spite of their limitations, such estimates are necessary if the so-called "permissible" levels of radiation for human populations are to have a rational basis.

Osteosarcomas

Unfortunately, comparable estimates of the strontium-90 hazard in terms of numbers of seriously affected individuals are lacking, although the importance of

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the strontium-90 hazard has received considerable emphasis (see 2, p. 80). The omission might in part be remedied by using estimates based on the natural incidence of osteosarcomas, but no figure for the natural incidence is given in either of the reports cited. However, the approximate incidence is known from a survey of the province of Saskatchewan (*3*), which revealed 47 cases in a population of approximately 900,000 over the 13-year period from 1932 to 1944. For convenience, this frequency can be expressed as 12,000 cases per 100 million people per 30 years.

It is unlikely that these osteosarcomas were all caused by the natural background radiation in bone (about 7 roentgens per 70-year life-span), and it is also unlikely that the number of radiation-induced osteosarcomas increases linearly with dose (the only published response curve being sigmoid in shape, *4*). However, these two assumptions might be used to arrive at an approximate *upper limit* for the damage from osteosarcomas from a given exposure to a large population (Fig. 1, curve *A*).

For example, if the first of the two assumptions is in error and a part of the osteosarcomas is not radiation-induced, or if a part is caused by clinical x-rays, the true yield per unit dose would be less than the estimated upper limit (Fig. 1, curve *B*). If, in addition, the second assumption is in error, and the response curve is really sigmoid (Fig. 1, curve *C*), or there is a "threshold," the yield per unit dose would be still less, at least at the lower doses.

It is a little more difficult to show that the two assumptions lead necessarily to an upper limit at the higher doses, but additional information can be used in this connection. Both reports (*1*, *2*) state that 1500 roentgens is the lowest clinical exposure known to produce an osteosarcoma. There is no indication concerning the probable number of individuals receiving such an exposure, but a second very approximate point might be inserted on the dose-effect plot if we think of the incidence as perhaps somewhere in the range from 1 in 10 to 1 in 10,000. On our two assumptions, a dose of 1500 roentgens would be expected to produce about 1 osteosarcoma per 40 people, but the true incidence at this dose is almost certainly very much less. Further, since exposures lower than 1500 roentgens have given rise to no reported cases of bone cancer, it would seem that the response curve must drop rapidly with decreasing exposure (see 5). Thus it is unlikely that the true response curve passes above the linear curve *A* (Fig. 1). A similar conclusion might also be drawn from the studies on radium poisoning.

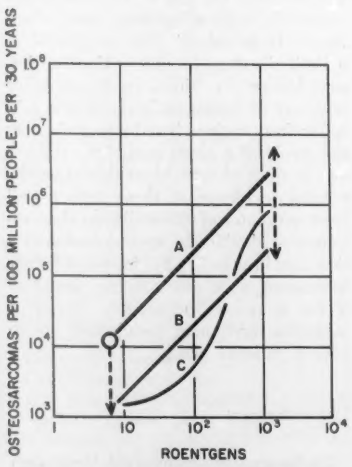

Fig. 1. Dose-effect relationships for radiation-induced osteosarcomas, based on three sets of assumptions.

Table 1. Upper limits for the hazard from strontium-90 induced osteosarcomas compared with conservative estimates of the genetic hazard.

Item	Strontium-90 hazard (tumor induction in bone)			Gamma radiation hazard (genetic effects)	
	Sr^{90} concn. (μμc/g of Ca)	Radiation in bone (rep per 70-yr life-span) (*8*)	Osteosarcomas (per 100 million people per 30 yr) (upper limit)	Radiation in the gonads (rep per 30 yr to average reproductive age) (*9*)	Serious hereditary defects (per 100 million people per 30 yr) (conservative estimate)
Nature		7	(12,000)	3	(2,500,000)
Fallout from weapons tests (*10*)					
1956 (milk, Canada)	5	1	1,700	0.1	6,250
Possible 1966	35	7	12,000	0.1	6,250
Possible equilibrium	70	14	24,000	0.1	6,250
Arbitrary levels of exposure to populations above which concern is expressed					
U.K report (*11*)	10 to 100	2 to 20	3,400 to 34,000	6	375,000
U.S report (*12*)	50	10	17,000	10	625,000

Table 1 shows the probable *maximum* number of osteosarcomas, based on the afore-mentioned assumptions, for various strontium-90 levels in a hypothetical population of 100 million people over a 30-year period. The true number of osteosarcomas in each case may be anywhere in the range from zero to the number shown. For comparison, an estimate of the genetic damage which would occur at the same time has been included, based on a "doubling dose" for mutation of 40 roentgens per generation and a natural incidence of severe hereditary defects of 2.5 per 100 people. It is considered that this represents a conservative estimate for the genetic damage (*6*). The numbers are those for sustained increases in radiation background extending over many generations. About one-tenth of this damage would appear in the first generation following an increase in the radiation background, but, when long-term hazards are being considered, the number shown would seem to be the important one.

Future Levels

Table 1 deals in part with possible future levels for strontium-90 and penetrating radiation, on the assumption that weapons testing in the future will continue as it has over the past 5-year period. The projected strontium-90 levels cannot be considered as "estimates," because too many of the variables are unknown. They are, however, values which have been discussed as "possible" and are thus important in the absence of anything more reliable. It should be noted that the combined natural incidence of all types of bone malignancy is in the vicinity of 2 to 3 times that of osteosarcomas alone; thus, if strontium-90 is thought to induce other types of bone tumor, the upper limits for the numbers of seriously affected individuals will be greater than those indicated in Table 1 by as much as two- or three-fold. Also, leukemias have been omitted so far from the present discussion because they appear to have been much less common as a cause of death, both in animal experi-

ments with radioactive strontium (*1*) and in cases of radium poisoning in man (*2*), possibly because only a part of the hemopoietic system is exposed to the radiation from bone-seeking materials. Others have estimated the effect of fallout on leukemia, on the assumption that strontium-90 is as effective as the equivalent penetrating radiation, at least with regard to the induction of those kinds of leukemia which are believed to originate in the bone marrow (*7*). However, the estimates others have obtained are very similar to the numbers indicated in Table 1 for osteosarcomas and do not greatly alter the present comparisons. It should be noted also that the estimation of genetic damage neglects all except the serious hereditary defects, although the less serious defects tend to be inherited over a larger number of generations, and thus affect more people before they are eliminated.

Remembering that Table 1 compares an approximate *upper limit* for the strontium-90 induced osteosarcomas with a conservatively chosen estimate for the serious hereditary defects, two conclusions might be drawn from the comparisons.

First, fallout in the future might perhaps result in more osteosarcomas than serious genetic defects, but the reverse could equally well be true, and there is no certainty that there will be any osteosarcomas at the strontium-90 levels considered in Table 1. Thus, in spite of assertions to the contrary (see *2*, p. 80, paragraphs 4a and 4b) there are, as yet, no objective grounds for deciding which will be the greater of the two hazards.

Second, the "permissible" levels for strontium-90 exposure in large populations would seem to have been chosen with greater caution than those for penetrating radiation to the reproductive tissues. The numerical discrepancy in the estimated damage in the two cases as shown in Table 1 is in the range from ten-fold to 100-fold, and the true discrepancy may be much greater still. If we wish to be equally cautious with respect to both kinds of hazard, it would seem (i) that future revisions of the "permissible" levels for populations must be based on an attempt to assess the two kinds of damage in comparable terms and (ii) that there must be a common guiding principle in deciding how large an effect is acceptable in each case.

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11. Medical Research Council of Great Britain, *Hazards to Man of Nuclear and Allied Radiations* (H.M. Stationery Office, London, 1956), paragraphs 281, 283, and 360.
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H. E. Sigerist, Social Historian of Medicine

For more than 2000 years the history of medicine has been studied and interpreted in some form. During this period, the purposes that motivated those who concerned themselves with the past of medicine and the evaluations derived from the materials available to them have varied considerably. Throughout antiquity and indeed far into modern times, such activity was motivated by a doxographic interest—by a desire to learn and to present the opinions and methods of previous medical generations. The essential purpose behind these writings is perhaps closer to that of the modern writer of a medical paper, who cites his immediate predecessors in the particular field of interest, than it is to that of the historian.

Within the present century, a more sophisticated approach to medical historiography has become increasingly prominent and influential. The keynote of this approach is the proposition that medicine is an activity whose development can be most fully understood only when it is considered in relation to the network of social interaction within which it occurs. Taking the social character of medicine as a point of departure, its history becomes the history of human societies and their endeavors to cope with problems of health and disease. While a number of medical historians, both in this country and abroad, have studied the development of medicine in terms of social factors and institutional structures, the foremost proponent of a need for reinterpretation of medical history from this broader viewpoint was Henry Ernest Sigerist, commonly recognized as the leading medical historian of his generation. Consequently, it was an occasion of distress and sorrow for the many who had known him personally or

through his writings to learn that Dr. Sigerist had died, on 17 March 1957, at his home in the village of Pura in Switzerland.

Sigerist came to the United States in 1931 as a visiting lecturer. While in this country he was asked by William H. Welch to succeed him in his chair of medical history at Johns Hopkins University and to become the director of the first American Institute of the History of Medicine. Welch wrote that Sigerist's "coming to Johns Hopkins is one of the most important events in the history of the University for years." The following 16 years brought to full fruition those qualities that won for him so great a number of students, friends, admirers—and adversaries.

Born in Paris on 7 April 1891, the son of a Swiss businessman, Sigerist was brought up in Zurich and, at the age of 20, spent a year (1910–11) at the School of Oriental Studies in London. After receiving his medical degree at Zurich in 1917, he served for 2 years as a physician in the Swiss army. After the end of World War I, in 1919, he turned to postgraduate work in medical history under the great German medical historian Karl Sudhoff, whom he succeeded in 1925 in the chair of medical history at Leipzig, after a short period at Zurich.

Sigerist brought home to his American auditors the meaning and potentialities of scholarship in relation to medical history. But the potentialities that he saw in historical study involved an organic linking of the past not alone with the present but equally with the future. "To me," he wrote, "the best way to understand a complex phenomenon has always been to study its genesis." Furthermore, at Zurich and then at Leipzig, he had been developing his recognition that medicine is but one aspect of the general civilization of a period—"that it is always determined by the general cultural conditions and by an underlying philosophy." As a stage in this process there comes to mind Sigerist's endeavor, in 1928, to define the position of William Harvey in European cultural history by analyzing his work as an instance of Baroque biology. Eventually he expanded this view into a broad sociologic concept in which medicine was seen within a matrix at once political, economic, social, and cultural. For Sigerist this concept was a tool which made it possible to investigate the past not only for its own sake but as a means of contributing to the urgent present problems of medicine and of helping to prepare the future. In his book *Medicine and Human Welfare* (1941), he set forth his position as follows: "The historian of medicine wants to know what has happened in the past and what is happening today. He endeavors to understand the phenomena of health and disease and their significance for the individual and for society."

From such a broad, socially oriented position, it is as logical to study the contemporary development of medicine as to analyze its evolution in the past. And to this endeavor Sigerist bent a considerable part of his energies while he was at Johns Hopkins. His visit to this country in 1931 was followed by a study of medicine in the United States [*Amerika und die Medizin* (1932); *American Medicine* (1934)]. Because of his belief that "the future of medicine will largely depend on what will be done in the United States and the Soviet Union," he then proceeded to study medical developments in the latter country. His account of *Socialized Medicine in the Soviet Union*, which appeared in 1937 and was reissued in a revised edition in 1947, was thus a necessary complement to what he had written about American medicine. In addition, Sigerist studied medical conditions in South Africa in 1939, and after World War II he visited India, Ceylon, the Philippines, and western Canada for the same purpose. Combining theory and practice, Sigerist worked actively for the establishment of an organization of medical care that would be more in consonance with the needs of our time. He was intimately involved with the movement for a national health insurance act in the United States and was also called on for counsel in other countries on problems concerned with the reorganization or improvement of medical care.

During this period, Sigerist also developed a comprehensive theoretical structure for the social history of medicine, which he intended eventually to write. Several books published in the 1940's may be considered interim reports in this process. The Terry lectures, which Sigerist gave in October 1940, at Yale University, appeared the following year under the title *Medicine and Human Welfare*. They were followed in 1943 by the publication of *Civilization and Disease*—the Messenger lectures, given at Cornell University in 1941. In these lectures Sigerist undertook to correlate the development of medicine with the history of human society. The method by which he did this was to seek out and analyze the points at which civilization (or culture) and disease have interacted and affected each other. Among the fields he examined were economics, law, religion, philosophy, science, literature, art, and history. In relation to these he studied disease, health, and the physician. These studies were to culminate in a monumental eight-volume history, of which the first volume appeared in 1951.

At the same time Sigerist did not neglect more specialized investigations or the teaching of medical history. A glance at the papers published while he was in Baltimore reveals the breadth of his interests. Medical geography, medieval medicine, health education, art and medicine, fee bills, hospitals, Boerhaave, Paracelsus, medical education, balneology, medicinal wines, public health and hygiene, medical etymology—these are only a few of the topics to which Sigerist turned his attention. Many of these papers appeared in the *Bulletin of the History of Medicine* which he founded. Fully aware that no scholar can work in a vacuum, he undertook to establish channels of communication for those concerned with medical history. To further this purpose he established several monograph series, as well as the *Bulletin*, and organized a number of conferences. Furthermore, in this connection he reorganized the American Association of the History of Medicine, imbued it with his own dynamic energy, and made the *Bulletin of the History of Medicine* its official publication. Perhaps most important was the fact that his humanistic approach, contagious enthusiasm, clarity of thought, honesty, and broad background of interest captivated physicians, medical students, and laymen alike. Sigerist was a great teacher, and there is no doubt that the increased interest in medical history in America at present is largely attributable to his influence.

After having been at Johns Hopkins for 15 years, Sigerist returned to Switzerland to write his projected *History of Medicine*. When the first volume appeared, in 1951, it was clear that while it dealt with only a few ancient societies, it nevertheless set a new pattern of medical historiography. Sigerist had, in a sense, worked all his life at the creation of this *History of Medicine*. Equipped with a wide knowledge of languages and of biological and social science, and with 25 years of research and teaching behind him, he was able to synthesize these various elements in terms of a clear-cut philosophy of history. It was clear that the social history of medicine had come of age. While his untimely death did not permit the completion of his original plan, it is apparent that he had at least formulated the plans and laid the foundations for a history of medicine which can see problems of health and disease not only from the viewpoint of the medical profession but from that of society as a whole.

Much more might be said about Sigerist, but one fact stands out above all. He has left with us some of his sense of freedom, his understanding of the problems of human welfare, and his faith in the future of mankind.

GEORGE ROSEN
School of Public Health and Administrative Medicine, Columbia University

News of Science

Foot-and-Mouth Virus Photographed

H. L. Bachrach and S. S. Breese, Jr., of the Plum Island Animal Disease Laboratory of the U.S. Department of Agriculture, report that they have purified, isolated, and photographed the foot-and-mouth disease virus. Their first electron micrographs of the virus show that it is spherical in shape and about one-millionth of an inch in diameter. This is the smallest of any of the viruses affecting animals—even smaller than poliovirus. These new findings about the physical makeup of foot-and-mouth disease virus are expected to speed research on the development of new and effective means of combating the disease, which has great economic importance to livestock production throughout most of the world.

Educational TV and IGY

Five new series of live television programs will be broadcast over the National Educational TV network beginning 28 Oct., with one of the series to be devoted to the International Geophysical Year. Inauguration of the new programs will constitute the second part of the cooperative effort by the Educational Television and Radio Center, Ann Arbor, Mich., and the National Broadcasting Company to bring national live programs exclusively to the noncommercial educational television stations.

In addition to the IGY programs, other series will be in the areas of American resources, current affairs, and the creative arts. The American resources series will explore the ways in which natural resources condition a population's way of life. Each of the series will include ten programs broadcast over a 10-week period on weekday nights at 6 P.M., Eastern standard time.

The IGY series will be directed to a general audience, but special attention will be given to making it meaningful to young people. Eminent scientists will appear, and close working relationships have been established with the U.S. National Committee for the International Geophysical Year. Visual resources will be drawn from film cleared for this use by the IGY, from remote coverage where activity is particularly important, and from specially prepared models and devices.

WHO Approves Fluoridation

The World Health Organization has reported that the use of fluoridated drinking water to prevent tooth decay is safe, effective, and practical. After having studied hundreds of fluoridation programs in 17 countries, a WHO committee has announced that the use of fluorine in drinking water supplies is approved by responsible public-health officials throughout the world.

In the United States 32 million people in more than 1500 communities are drinking fluoridated water. Sixteen other countries have begun similar programs.

The WHO committee report emphasized that results in all nations using fluoridated drinking water show remarkable uniformity. Dental caries in the permanent teeth of children decreased by about 60 percent, while in children's primary teeth the reductions ranged from 50 to 60 percent.

No other public-health procedure has had, during the initial stages of its application, such a background of study in terms of both time and expense, the report said. Without qualification or caution, WHO recommends the use of fluoridated drinking water wherever and whenever possible. It was suggested that treated water contain 1 part of fluorine for every 1 million parts of water.

Scientific Languages and Britain's New Secondary Technical Schools

Russian was recently selected as the second most important scientific language by the Hatfield School, one of England's new secondary technical schools. Further, at Hatfield German, rather than French, is now the first language for students receiving extensive science instruction.

Hatfield School is only 3 years old, for the technical schools are the newest of the three-part secondary-school system in Britain. Secondary education includes youngsters from the ages of 11 to 15. The oldest of the secondary schools are the grammar schools, which are college preparatory and have a program that is strong in the classics. Competitive examinations select the top 20 percent of the 11-year-olds who enter the grammar schools.

The Education Act of 1944 led to the establishment of the state-supported secondary technical schools. Like the grammar schools, these are selective in their enrollment; however, they differ in that they emphasize science rather than the classics, and their curricula bear a relationship to the industry or commerce of the particular region in which they are located.

The development of the technical school is coupled with the growing importance of technicians in English industry. Like the United States, Britain has a grave shortage of engineers.

The graduates of the technical schools usually go to work after completing their secondary education and their military service. But reaching the legal age for leaving school, now 15 but in the process of being raised to 16, does not mean the end of education for most of them. Many take further education 1 day a week at the county colleges on time released by their employers. The large enrollment in these free schools is closely related to England's efforts to raise the compulsory school age to 16 as soon as staff and facilities are sufficiently increased.

Industry Group Considers Formation of Nuclear Center

Four major United States companies have established a group of scientists and economists to study the technical and economic feasibility of building and operating a nuclear testing center with private capital. Announcement of this Nuclear Test Center Study Group was made jointly by the heads of the cooperating companies: ACF Industries, Inc., Kaiser Engineers, Lockheed Aircraft Corporation, and Phillips Petroleum Company.

The concept of such a center conforms with the desire of the Atomic Energy Commission and the Joint Committee on Atomic Energy to hasten the time when nuclear testing facilities will be built and operated with private capital rather than with Government funds. The services of the potential test center would be available to Government agencies, educational institutions, and both domestic and foreign industrial enterprises.

Among the many facilities that would be included in the center are a very high

neutron-flux test reactor and supporting laboratories. The Nuclear Test Center Study Group has established headquarters at 1625 I St., NW, Washington, D.C., under the direction of R. M. Jones of ACF Industries.

Seismological Coordinates for Underground Nuclear Test

The Atomic Energy Commission has released the following seismological information about the underground nuclear explosion that took place at the Nevada Test Site on 18 Sept. [*Science* **126**, 200 (2 Aug. 1957)]. Seismologists can establish the position of the blast by using the following: latitude 37° 11.7′ north, longitude 116° 12.2′ West; altitude 6611.43 feet above mean sea level.

CERN Synchrocyclotron Operating at Full Energy

The synchrocyclotron, first of the two high-energy accelerators being built by the European Organization for Nuclear Research (CERN) in Geneva for the use of European scientists, is now working at its full energy, according to C. J. Bakker, director-general of CERN. After little more than 2 years of work at the CERN laboratory center, the staff of the synchrocyclotron division, which is under W. Gentner, was recently able to conduct test runs with the machine at its peak output energy of 600 million electron volts. The internal current during the first runs was about 0.1 microampere. Later the current of high-speed nuclear particles is expected to be increased.

The CERN synchrocyclotron is the third biggest of its kind in the world. Slightly bigger machines are in operation at the Radiation Laboratory, University of California, Berkeley (U.S.A.), and at the Joint Institute for Nuclear Research at Dubno near Moscow (U.S.S.R.).

The other machine being built by CERN, the 25,000-million electron volt proton synchrotron, is still under construction. This accelerator is expected to be completed by late 1960.

Geographic Field Research Abroad

In 1958 the National Academy of Sciences–National Research Council will conduct, under the financial sponsorship of the Office of Naval Research, its third annual program of geographic field research in foreign areas. Since 1955, awards have been made to 18 young Americans to carry out field research on topics of their own choosing for periods ranging up to 14 months.

The objective of the program is to strengthen American geography by stimulating greater participation by young Americans in field research in areas outside of the United States. Support will be made in related fields, such as geomorphology, climatology, ecology, and pedology.

The program is designed primarily for graduate students who wish to conduct field research in connection with their doctoral dissertations, but investigators who have received the doctorate within the last few years are also eligible. More mature scholars may submit research proposals to the Geography Branch, Office of Naval Research, Washington 25, D.C.

The extent of financial assistance will vary according to need. The intent is to provide adequately for travel, field, and living expenses. Usually there is no stipend. A preference will be shown for field investigations of at least 6 months' duration. Recipients of support must agree to submit a detailed report of their investigations, suitable for publication, to the Division of Earth Sciences, NAS–NRC.

Applications for support of field work to be initiated before 1 Apr. 1959 must be submitted *before 1 Dec.* All applications or requests for further information should be addressed to: Foreign Field Research Program, Division of Earth Sciences, 2101 Constitution Ave., Washington 25, D.C.

Arctic Institute

The Arctic Institute of North America is offering field research support in 1958 for scientific investigations dealing with the arctic and subarctic regions of North America. Applications are invited by those who have demonstrated their ability to conduct research work of superior quality in some field of science.

Priority will be given to field investigations, although studies at one of the institute offices will be accepted. Proposals in the broad field of the earth sciences, in marine biology, and in physiology are especially desired. Facilities of the Arctic Research Laboratory at Barrow, Alaska, are available for a limited number of investigators for both summer and winter programs. The facilities include both housing and equipment.

Application forms may be obtained from the Arctic Institute of North America, 3485 University St., Montreal 2, P.Q., Canada, or 1530 P St., NW, Washington 5, D.C. Completed applications should be received *before 1 Nov.* Late applications will be considered in special circumstances only, if additional research funds become available.

The Institute is also in a position to award grants from funds provided by the trustees of the Banting Fund primarily to encourage Canadians, particularly recent graduates, in northern studies. Inquiries should be addressed to the Arctic Institute's Montreal office.

Geomorphology Journals

Publication of two leading journals in geomorphology, both of which were discontinued during World War II, has been resumed with the appearance of the *Zeitschrift für Geomorphologie,* under the editorship of Hans Mortensen of Goettingen, and the *Revue de Geographie Physique et de Geologie Dynamique,* under the editorship of J. H. Brunn of Paris. Each starts with a new series and initial volume for 1957.

More Animal Study Urged

The Institute of Laboratory Animal Resources has passed the following resolution urging the study of animal diseases:

"The Institute of Laboratory Animal Resources, cognizant of the need for a broader understanding of animal diseases, both for the practical purpose of providing medical and biological research with the best possible investigative animal materials and for the broader purpose of promoting research on animal diseases for a better understanding of biological and pathological phenomena in general, strongly urges the intensification of basic research in the field of animal pathology and, in particular, of the diseases of animals used in laboratory investigations and testing."

NBS Summer Program

The 1957 Summer Student Program at the National Bureau of Standards began on 2 July with the largest enrollment on record, 238 students in the Washington, D.C., area and 25 students at Boulder, Colo. This program, an integrated plan of laboratory work assignments, orientation, and special training, is designed and administered for the purpose of acquainting young physical scientists and engineers with the career opportunities and contemporary activities at NBS.

Of the 263 students, 120 were returnees from previous years and the remainder were new students. Eighty of the group are graduate students, combining summer-work assignments at the bureau with their advanced degree programs. Sixty colleges and 25 states were represented by the new group, with men outnumbering the women 8 to 1. In ad-

dition to special training and the opportunity for supplementing college courses with work in a professional laboratory, students obtain both academic and career guidance through contact with professional men and women.

Antarctica a Group of Islands?

G. A. Avsyuk, who is in charge of the glaciological investigations of the Soviet International Geophysical Year Committee, recently told a Tass correspondent that Soviet scientists suspect that Antarctica is not an ice-capped continental land mass but a group of islands. Exchanges with American, British, Norwegian, and Swedish expeditions in other parts of the Antarctic have confirmed that the ice cap in several places is below sea level.

Scientists in the News

ROBERT B. CASADY, formerly associate professor in animal industry and zoology at North Carolina State College, has been appointed director of the U.S. Rabbit Experiment Station, Fontana, Calif., succeeding GEORGE S. TEMPLETON, who has retired after 23 years of service.

JEROME ROTHSTEIN has joined Edgerton, Germeshausen and Grier, Inc., of Boston, Mass., as a senior scientific executive. He will be responsible for the execution of research and development projects. Rothstein has for the past 15 years conducted research at the U.S. Army Signal Corps Laboratory, Fort Monmouth, N.J. His work has included the design of the reentrant annode seal for high-power thyratrons and the use of titanium hydride as a reservoir material to replenish hydrogen in high-power thyratrons. Both of these developments are now standards for industry.

CHARLES W. SHEPPARD has joined the department of physiology at the University of Tennessee Medical School as an associate professor. Formerly he was associate director of the Biology Division, Oak Ridge National Laboratories. Sheppard is conducting investigations in cardiovascular physiology, especially dye mixing in the circulating blood.

HORACE A. HOLADAY, who has been with E. R. Squibb and Sons for 37 years, has retired from active service. Holaday graduated from the University of Colorado. He then taught chemistry there and later at the University of Idaho. He took graduate work at the Universities of Colorado, Idaho, Columbia, North Dakota, and Chicago. After serving in the Army in World War I, he returned to Columbia University and then went to North Dakota College, where he became head of the division of food and physiological chemistry.

In 1920, Holaday joined Squibb as director of biochemical research. His most recent post was that of assistant to the vice president and director of manufacturing operations.

RICHARD T. SCHLICK, formerly on the development staff of Leeds and Northrup, has been appointed chief chemist, instrumental methods, for Fisher Scientific Company, Pittsburgh, Pa.

ERNEST HAVEMANN, magazine writer, is the first winner of the American Psychological Association's newly established $500 award for distinguished science writing in the field of psychology. He was honored for a five-part series in *Life* magazine, 7 Jan. 1957 to 4 Feb. 1957, on psychology and psychiatry in American life today.

ERNEST O. LAWRENCE, Nobel laureate and professor of physics at the University of California, has been named winner of the first Sylvanus Thayer award of the Association of Graduates of the United States Military Academy. The presentation will take place at West Point next March.

The award is named for the superintendent of the academy from 1817–33. It is to be given annually to an American citizen whose service and accomplishments in the national interest exemplify the principles expressed in West Point's motto—"Duty, Honor, Country."

WILLIAM H. PEARLMAN, biochemist and specialist in steroid hormone action in relation to problems in human reproduction and cancer, has returned from 3 years of work at Guy's Hospital Medical School in London to join the staff of the Waldemar Medical Research Foundation, Port Washington, L.I., as associate scientific director.

K. E. MARPLE, manager of the Denver Agricultural Research Laboratory of the Shell Development Company, has been named director of the company's Agricultural Research Division. The division's laboratories at Denver, Colo., and Modesto, Calif., are being consolidated in new facilities now under construction at Modesto. Marple will assume his new duties there on 15 Nov. He replaces S. H. McALLISTER, who has been appointed manager of Shell Chemical Corporation's Agricultural Chemical Sales Division, head office, New York.

T. R. HANSBERRY, manager of the Modesto laboratory, has been named assistant director of the division and will be in charge of the biological sciences.

MARY M. PORTER has been named chairman of a new department of clinical pathology at the Woman's Medical College of Pennsylvania. Two new faculty appointments have also been announced: IRVIN J. PINCUS is associate professor in the department of medicine, and ANTHONY L. PIETROLUONGO is associate professor in the department of pathology.

JASON J. NASSAU, head of the astronomy department at Case Institute of Technology, was honored on 7 Sept. when the institute's new astronomical station in Geauga County was dedicated in his name. Case's 36-inch Schmidt-type telescope, one of the largest instruments of its kind in the world, has been moved to the station from the Warner and Swasey Observatory on Taylor Road. The Warner-Swasey Company is completing work on another 36-inch reflecting telescope that will replace the Schmidt instrument at the Taylor Road observatory. This will be installed in 2 months and dedicated on 15 Dec.

JAMES S. BRIERLEY has been named to the newly created position of chief engineer, research planning, coordination, and administration for the Chrysler Corporation, Detroit, Mich. He will be responsible for establishing research program objectives, preparing technical research plans, and coordinating programs within the research organization as well as with other areas in the Engineering Division. Since joining the division in 1955, Brierley has been associated with the nuclear research program.

ARTHUR CHERKIN, chemist and vice president and director of research at Don Baxter, Inc., pharmaceutical house in Glendale, Calif., has been chosen to head the company's new international division. Also at Baxter, WILLIAM H. CORCORAN, formerly professor of chemical engineering at the California Institute of Technology, has accepted a post as head of the newly formed scientific division. He joined the company on 1 Sept. as vice president and scientific director.

JOHN H. MANHOLD, JR., has been promoted to full professor and director of the department of oral pathology and diagnosis of Seton Hall College of Dentistry. In addition, he will serve as coordinator of research for the dental school. Manhold joined Seton Hall last

year after serving in a similar capacity at Washington University School of Dentistry in St. Louis. Seton Hall College of Dentistry started its second year of operation on 9 Sept. with 44 new students.

ROGER G. BATES has been appointed chief of the Physical Chemistry Section of the National Bureau of Standards. He succeeds E. R. SMITH, who retired in June. Bates, a specialist in *p*H measurement, has been a member of the NBS staff since 1939.

JOHN J. DROPKIN has been named head of the physics department at Polytechnic Institute of Brooklyn, where he has been a faculty member since 1948. He succeeds PAUL P. EWALD, who will remain at Polytechnic as professor of physics. A pioneer in the field of x-ray crystallography, Ewald joined Polytechnic from Belfast University in 1949.

FATHOLLAH K. MOSTAFI, has been appointed scientific director of the American Registry of Pathology at the Armed Forces Institute of Pathology. He succeeds HUGH G. GRADY, who resigned the post to become professor of pathology at the Seton Hall College of Medicine and Dentistry. Mostafi has been chief of the Genito-Urinary Section of AFIP since 1948, a post he will continue to hold in addition to his new appointment.

DAVID TURNBULL, manager of the chemical metallurgy section at General Electric Research Laboratory, Schenectady, N.Y., recently sailed for England, where he will spend 6 months studying and lecturing at Cavendish Laboratory, Cambridge University. The "research leave" granted to Turnbull is part of a new program at General Electric designed to give the company's scientists an opportunity to spend 6 months in postgraduate studies at leading universities here and abroad. The new type of leave at G.E. was created to parallel the sabbatical leave in academic institutions.

CHARLES P. HUTTRER, assistant chief in the Cancer Chemotherapy National Service Center, National Cancer Institute, has been appointed assistant chief in the grants and training branch of the National Heart Institute.

VINCENT SAUCHELLI, director of agricultural research at Davison Chemical Company, a division of W. R. Grace and Company, has joined the staff of the National Plant Food Institute, Washington, D.C., as chemical technologist.

ALBERT CAROZZI, formerly of the University of Geneva, Switzerland, has been appointed associate professor in the department of geology at the University of Illinois. He will teach structural geology and related subjects. Carozzi was visiting assistant professor at Illinois in 1955–56.

ISLES STRACHAN of the University of Birmingham, England, is visiting lecturer at the University of Illinois for the current year. A specialist on graptolites, he will teach paleontology.

WILLIAM SHARP McCANN, emeritus Dewey professor of medicine in the University of Rochester School of Medicine and Dentistry and emeritus physician-in-chief at Strong Memorial Hospital, has been named a visiting professor in Cornell University's Sloan Institute of Hospital Administration.

GRACE B. BELL has been appointed dean of the College of Osteopathic Physicians and Surgeons (Los Angeles). She has been serving as professor and executive in the college's department of biochemistry.

Brig. Gen. THEODORE A. WEYHER has been appointed dean of the School of Engineering of the University of Miami. He retired in June from his post as commanding general of the Army Ordnance Weapons Command.

LLOYD W. ROOT, former associate professor of physics at the University of Dayton, has been named director of research for the precision optical glass division of George Behm and Sons Company, Dayton, Ohio.

Recent Deaths

CHARLOTTE A. BRAGG, Melrose, Mass.; 94; retired in 1929 as professor of chemistry at Wellesley College; 31 Aug.

GEORGE G. BROWN, Ann Arbor, Mich.; 60; chemical engineer; dean of the University of Michigan College of Engineering since 1951; pioneer in combustion and fractional distillation; former director of the U.S. Atomic Energy Commission's Division of Engineering; 26 Aug.

SNOWDEN D. FLORA, Topeka, Kan.; 78; meteorologist in the Topeka Weather Bureau Office, 1905–49; named chief meteorologist for Kansas in 1912; developed flood prediction scheme that enabled him to forecast the 1935 flood level 24 hours in advance; 27 Aug.

PETER FREUCHEN, New York, N.Y.; 71; Danish explorer and author; founder and governor of the Thule colony in Greenland; made expeditions to Arctic Canada, Greenland, Hudson Bay, Arctic Circle; underground leader in Denmark during the German occupation in World War II; held the Danish Royal order of Merit with two bars; United Nations correspondent for *Politiken,* largest newspaper in Denmark; 31 Aug.

CONRAD JOBST, Toledo, Ohio; 67; mechanical engineer who invented an elastic stocking to ease varicose veins; former chief engineer of the Toledo Automatic Brush Company and the Stapletied Brush Company; 28 Aug.

EUGENE J. KELLY, Yardley, Pa.; 53; former member of the dental faculty of Columbia University; past president of the Northeastern Society of Orthodontists; 20 Aug.

ROY H. KIENLE, Riverside, Conn.; 61; director of the research service department in the Stamford (Conn.) Laboratories of American Cyanamid Company; research chemist at General Electric Company, Schenectady, N.Y.; 1919–33; 2 Sept.

EDGAR L. LONGAKER, Philadelphia, Pa.; 75; pioneer in the development of storage batteries for submarines and automobiles; retired manager of design engineering for the Exide Industrial Division of the Electric Storage Battery Company; 29 Aug.

HENRY B. ORTON, Newark, N.J.; 71; internationally known laryngologist who advocated deep-neck surgery in cases of cancer of the larynx; former professor of laryngeosurgery at New York Polyclinic Medical School and Hospital; 1 Sept.

GEORGE RETIVOV, New York, N.Y.; 59; electrical engineer; White Russian who fought in the Russian revolution of 1917; resided in Germany and Czechoslovakia until coming to this country after World War II; 1 Sept.

WILLIAM RAMBHAAR, New York, N.Y.; 70; specialist in synthetic resins; established Krumbhaar Chemicals, Inc., South Kearny, N.J.; 26 Aug.

ROBERT L. SIBLEY, Abilene, Tex.; 69; chemist, retired in 1952 from Monsanto Chemical Company as research director and general manager of the rubber services department in Nitro, W.Va.; 18 Aug.

WINIFRED B. STEWART, Philadelphia, Pa.; 56; professor of neurology at Woman's Medical College of Pennsylvania; former director of the neuropsychiatric division of Quarter Sessions Court and visiting chief of the psychiatric department of Philadelphia General Hospital; 20 Aug.

Erratum: The recent obituary notice for Ward Evans [*Science* 349, 126 (23 Aug. 1957)] contains the inaccurate statement that he was the "lone member of the Atomic Energy Commission's special three-man Personal Security Board of 1954 who ruled that J. R. Oppenheimer was a loyal citizen." It is correct that Evans was the only member of the board who recommended that Oppenheimer should retain his security clearance; however, the majority report affirmed emphatically the belief that Oppenheimer was a loyal citizen and pointed out his eminent services to his country.

Reports

"Atom Bomb Effect"—Recent Increase of Carbon-14 Content of the Atmosphere and Biosphere

In a study of C^{14} variations in nature (*1*), collection of atmospheric carbon dioxide for the measurement of its C^{14} activity commenced in New Zealand on 24 Nov. 1954. The first three results were reported (*1*) in 1955, and the mean value +3.73 percent with respect to the New Zealand wood standard apparently agreed well with Craig's predicted value of +3.68 percent (*2*). There was, however, in these results an indication that the C^{14} content of the atmosphere was increasing; hence, the sampling program was continued to check whether or not there was a seasonal variation or a C^{14} enrichment of the atmosphere by atomic explosions. Nine samples of air have been assayed since 3 June 1955. The results indicate a steady increase in the C^{14} content of the atmosphere. Duplicate samples collected over the period 12 Dec. 1956 to 23 Mar. 1957 have assayed $+7.60 \pm 0.03$ percent and 8.05 ± 0.30 percent with respect to the New Zealand wood standard. Taking the average value +7.83 percent for the C^{14} enrichment of air for the first 3 months of 1957, these results show that the C^{14} content of the atmosphere of the Southern Hemisphere has increased by 4.10 ± 0.5 percent since February 1955.

Because of the recently reported depletion of the C^{14} specific activity of the atmosphere (*3*) owing to the combustion of fossil fuels (the so-called "industrial effect"), before the total increase in C^{14} content of the atmosphere can be deduced from the foregoing figures, allowance must be made for this effect in (i) the atmosphere at the present time; (ii) the atmosphere prior to high-power atom-bomb tests (1953); and (iii) the New Zealand wood standard used in these comparisons.

It has recently been shown in this laboratory (*4*) that, up to 1953, a worldwide depletion of 2.0 percent in the C^{14} specific activity of the atmosphere has occurred. The New Zealand wood standard is depleted by only 1.5 percent. Thus, 1953 air with respect to 1953 wood should show a +3.7 percent enrichment factor, but when assayed with respect to the New Zealand wood standard, it should show only a +3.2 percent enrichment factor. Furthermore, depletion of atmospheric C^{14} specific activity is still occurring at a rate of approximately 0.05 percent per year; hence, 1957 air should assay +3.0 percent with respect to the New Zealand wood standard.

Since the average value in early 1957 is +7.8 percent with respect to the New Zealand wood standard, the increase in C^{14} content of the atmosphere of the Southern Hemisphere since 1953 is (7.8–3.0) percent—that is 4.8 ± 0.5 percent of the C^{14} normally present.

Since these results must be of considerable value in the calculation of atmospheric and ocean circulation times, an attempt has been made to verify these data by other methods of sample collection. To obtain sufficient carbon dioxide to achieve the maximum accuracy from equipment currently in use (*5*), the carbon dioxide has to be completely removed from 2500 to 3000 ft^3 of air. This has been done by the method previously described (*1*), but an alternative and quicker method is simply to expose trays of barium hydroxide solution to the atmosphere. In 7 to 10 days, 20 to 30 lit of carbon dioxide can be recovered. Samples collected by this method show an increase in C^{14} specific activity of 4.90 ± 0.60 percent between May 1955 and May 1957.

If such an increase has really taken place, it should be detectable in the wood and leaves of trees, grass, and so forth. To test this conclusion, the youngest leaves were taken, in May 1957, from a tree growing in a locality from which wood and leaf samples had previously been assayed. The results of these measurements indicated an enrichment of 4.25 ± 0.5 percent with respect to 1953 wood. The good correlation of the C^{14} enrichment of the atmosphere with that of the contemporary portion of the biosphere is in agreement with the expected rapid exchange between these carbon reservoirs.

The exchange rate of carbon dioxide between the atmosphere and the ocean is also a quantity of considerable importance. Since measurements on sea-water samples had been made (*1*) in November and December 1954 (when the increase of C^{14} in the atmosphere was very small), further 80-gal samples of sea water were collected from the same location, to establish whether or not an increase could be detected in surface ocean water. A steady increase has been apparent, especially since late 1956, and samples collected in May 1957 show a C^{14} enrichment of 2.0 ± 0.5 percent with respect to samples collected in late 1954.

Current estimates of the exchange rate of a CO_2 molecule from the atmosphere to the ocean range from 7 to 10 years (*6*), while the measurements reported here indicate a value of approximately 18 months. However, since the sea water has been collected from a rocky seacoast, it may not be representative of surface ocean water. Surface ocean waters from the South Pacific are therefore being investigated to check for any coastal effect.

It is appreciated that these results are too few and should be checked in other parts of the world before any generalization about atmospheric circulation or atmosphere-ocean exchange times can be formulated. It is, however, interesting to use the data given by Libby (*7*) to estimate, from the C^{14} increase, the total power of atomic weapons to date. Libby states that, when a reasonable escape figure for neutrons from an atomic explosion of 15 percent is used, nearly 1000 megatons of TNT equivalent of fission would be necessary just to double the C^{14} content of the atmosphere on a short-term basis (before mixing with the sea occurs). The 4.8-percent increase for the atmosphere reported here would account, on this basis, for 48 megatons of TNT equivalent of fission. The actual value must be greater than 48 megatons, first, because the increase of C^{14} in the Northern Hemisphere must be greater than that observed in the Southern Hemisphere, and second, because it has been shown here that the biosphere and surface ocean waters have already absorbed some of the artificially produced C^{14} from atomic explosions.

Since all the atomic weapons tests to date have taken place in the Northern Hemisphere, it would be expected that the increase in C^{14} specific activity in the Northern Hemisphere would be greater than that observed in the Southern Hemisphere. A knowledge of the

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All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in Science 125, 16 (4 Jan. 1957).

present value in the Northern Hemisphere would thus yield important meteorologic data on the mixing rate of the atmospheres of the two hemispheres. If information on the power of all the weapons exploded to date were available, the rate of C^{14} increase in the Northern Hemisphere with time could be calculated fairly accurately. From a comparison of the atmospheric C^{14} specific activity with time in the two hemispheres, it should be possible to elucidate the mechanism and rate of the main mixing processes.

Should atomic weapons testing cease, the C^{14} specific activity of the atmosphere would begin to return to the preatomic bomb level as the result of exchange of CO_2 between the atmosphere and the oceans. The observation of this decrease and also of the change in C^{14} specific activity of surface water of the oceans would provide a valuable check on the exchange constants currently assumed for these reservoirs (*8*).

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8. A fuller discussion of these results will be published in the *New Zealand Journal of Science and Technology.*

27 June 1957

Effect of Rat Intrinsic Factor on Vitamin B_{12} Absorption in Pernicious Anemia

Castle's intrinsic factor greatly improves the intestinal absorption of vitamin B_{12}. In pernicious anemia, both normal human gastric juice and hog-stomach preparations are sources of the intrinsic factor.

Rats in which the glandular part of the stomach has been resected do not absorb radioactive vitamin B_{12}, unless rat gastric juice or homogenized rat stomach is administered simultaneously (*1*). Normal human gastric juice and different preparations derived from hog stomach are ineffective in the gastrectomized rat. On the contrary, some of these intrinsic factor preparations were found to decrease the absorption of vitamin B_{12} in the normal rat (*2*). These studies suggested the species specificity of rat intrinsic factor.

It was decided to supplement these data by a study of the effect of rat intrinsic factor on the absorption of radioactive vitamin B_{12} in patients with pernicious anemia. For this purpose, a modification of the urinary excretion technique described by Schilling (*3*) was used. Human gastric juice collected from normal donors after the injection of histamine was neutralized after filtration through gauze. It was pooled and kept frozen.

Rat gastric juice was obtained from animals in which the pylorus had been ligated after an overnight fast. Eight hours after the ligation the animals were sacrificed, and the gastric juice was collected. After filtration through gauze, it was neutralized. The nearly clear, slightly yellow, and tasteless fluid was kept frozen.

The excretion of radioactive vitamin B_{12} in the urine, collected over 48 hours after a test dose of 1 μg of CO^{58}-B_{12}, varied from 14.2 to 46.4 percent, average 29.1 percent, in 30 control subjects. In 14 patients with pernicious anemia, 0.05 to 4.35 percent, average 1.68 percent, of the test dose was recovered in the urine. After simultaneous administration of 25 ml of human gastric juice, the urinary excretion increased to 12.9 to 35.9 percent, average 22.3 percent, in 13 of the patients with pernicious anemia.

Data about the clinical activity of rat intrinsic factor are given in Table 1. The intrinsic factor activity of 25 ml of rat gastric juice was less than that of the same quantity of human gastric juice. In dialysis experiments performed by us, 1 ml of rat gastric juice was able to bind 0.029 μg of vitamin B_{12}, while human gastric juice bound 0.077 μg of vitamin B_{12}. If the amount of rat gastric juice given, together with the test dose of vitamin B_{12}, was increased to provide the same binding power as 25 ml of human gastric juice, rat intrinsic factor appeared to be about as active as human intrinsic factor in patients with pernicious anemia, at least in this short-term experiment.

These findings in human beings, who are able to utilize intrinsic factor derived from human, hog, or rat sources, are in striking contrast to the results previously obtained in the rat (*4*).

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4. This study was made possible by a gift of radioactive vitamin B_{12} from the N. V. Philips-Roxane Co., Weesp, the Netherlands. Technical assistance was given by J. H. Jans and A. O. de Vries.

18 June 1957

Table 1. Urinary radioactivity expressed as a percentage of the test dose of 1 μg CO^{58}-B_{12}.

Treatment	Case number					Average
	1	2	3	4	5	
B_{12} only	2.71	4.35	0.84	0.44	0.82	1.83
B_{12} + 25 ml of human gastric juice	25.1	25.8	12.9	21.2	27.3	22.5
B_{12} + 25 ml of rat gastric juice	11.6	11.3	7.76	5.56	3.47	7.9
B_{12} + 70 ml of rat gastric juice	19.1	23.4	22.8	20.6		21.5

Distribution of Lysogenic Streptomyces

Temperate bacteriophage might be responsible for outbreaks of *Streptomyces*-phage during antibiotic fermentation. However, few examples of lysogeny among the *Streptomyces* have been reported (*1*, *2*). Recently, three strains of *Streptomyces* which had been maintained in the laboratory for more than 2 years, with frequent colonial isolation, were found to be lysogenic. This prompted a survey of other laboratory strains and of some strains newly isolated from soil samples collected in Minnesota (*3*).

All strains were purified by at least 15 serial replatings from well-isolated colonies on AMC agar (*4*). Temperate phages were isolated from peptone-yeast extract broth cultures inoculated with fragmented aerial hyphae and incubated at 30°C on a reciprocal shaker. Although the cultures were sampled frequently, no free phage was detected until autolysis became evident. Phage-enriched autolysate was made by adding germinated spores of other strains of *Streptomyces* to an autolyzing culture. This frequently increased the numbers of free phage considerably but in no case led to the detection of a new lysogenic strain. In a few instances the addition of spores masked the phage already present in the autolysate.

Table 1. Distribution of lysogeny among *Streptomyces*. Plus sign indicates free phage present; minus sign, free phage absent; zero, not tested.

Strain	Free phage in	
	Autolysate	Phage-induced culture
S. griseus		
WAc-31	−	−
WAc-34	−	−
WAc-86	+	−
WAc-104	+	+
1945	+	−
1947	+	+
S. coelicolor		
WAc-16	−	0
WAc-133	−	0
WAc-135	−	0
S. cyaneus		
WAc-45	−	−
S. olivaceus		
WAc-11	+	+
Unidentified isolates		
247-A	+	+
247-M	+	+
247-Q	−	0
247-T	−	0
247-4	+	−
247-10	+	−

Some temperate phages were induced by the virulent phage, WSP-2 (*2*). These temperate phages were purified on hosts which WSP-2 could not attack. No other means of induction is known at present. By these three methods, nine of 17 strains tested were found to be lysogenic (Table 1). The presence of detectable phage in an autolysate was variable. One of a set of replica cultures frequently produced no free phage, whereas the other culture yielded as many as 10^5 bacteriophages per millimeter. Several of the temperate phages had similar host-ranges (Table 2).

Lysogeny is widespread among the *Streptomyces*. Many strains not now considered lysogenic will probably be found to contain temperate bacteriophage. Some of the temperate phages are able to attack the lysogenic strain from which they were derived. Apparently, lysogeny does not always confer complete resistance to the homologous temperate phage.

Table 2. Host-range of temperate *Streptomyces*-phages. Plus sign indicates lysis; minus sign, no effect.

Phage from	Hosts, WAc-				Host
	11 or 104	34	45	86	1945
WAc-104	+	−	−	+	−
1947	+	−	−	+	−
247-A	+	−	−	+	−
247-4	+	−	−	+	−
WAc-86	+	+	−	+	−
1945	+	+	−	+	−
WAc-11	+	−	−	+	+
247-M	−	−	−	+	−
247-10	+	+	+	−	+

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12 June 1957

Changes in Serum Proteins in Amphibian Metamorphosis

In a continuing survey of some of the biochemical changes which occur during amphibian metamorphosis (*1*), we have observed some remarkable alterations in the serum proteins during the transition of the tadpole to the frog. Significant changes in both the amount and the distribution of the proteins have been noted.

Our method of study involved utilization of a Spinco paper electrophoresis unit with Veronal buffer, *p*H 8.6, ionic strength 0.075, and containing 0.2 percent of Sterox SE (*2*). Blood samples were obtained by puncture of the conus arteriosus with a glass needle. Serum from the clotted blood was applied to Whatman 3-mm filter paper strips, in 10, 20, and 40 lambda portions, depending on the protein concentration of the serum. After electrophoresis (16 hours, 5 ma, 78 v) the strips were dyed with bromophenol blue, and patterns were prepared with a Spinco "Analytrol" (*3*).

Typical electrophoretic patterns of serum, obtained from the bullfrog, *Rana catesbiana*, at various stages in its life-cycle, are shown in Fig. 1. Additional data are summarized in Table 1. The serum of the young bullfrog tadpole showed a very low proportion of albumin (*4*) (about 10 percent of the total serum protein). The total serum protein concentration was also quite low (1.01 percent), as was the albumin/globulin (A/G) (*4*) ratio (0.11). After treatment with triiodothyronine, the relative percentage of albumin increased to about 16 percent (A/G, 0.25). The total serum protein concentration rose to 1.74 percent. Some displacement in the mobility of several protein fractions was also noted. A slow-moving fraction, with a mobility similar to human gamma globulin, was found present in the pattern for the tadpole treated with triiodothyronine. A fraction with a slightly greater mobility than this was present in the pattern for the froglet (a tadpole immediately after spontaneous metamorphosis). This latter fraction became pronounced in the adult frog.

The full extent of the changes which occur during the normal metamorphic period is seen in the data for froglets. In the froglet and the adult frog, the total serum protein concentration more than doubles over the level found in the young, undeveloped tadpole (1.01 percent to 2.56 percent), and the relative percentage of albumin increases to comparable values of 46 percent for the adult frog and 49 percent for the froglet.

Even more dramatic changes in serum proteins occurred during the development of the swamp frog, *Rana hecksheri*. As is indicated in Fig. 2, the serum pattern for most young *R. hecksheri* tadpoles showed no observable albumin fraction. As metamorphosis proceeded, an apparent (*4*) albumin fraction appears (A/G = 0.13). We have noted that a serum albumin fraction was also evident after induced metamorphosis with thyroid hormones. In the adult *R. hecksheri* frog the relative concentration of serum albumin reaches about 35 percent. The many interesting questions raised by the nature of the developmental changes in the protein components of serum in these

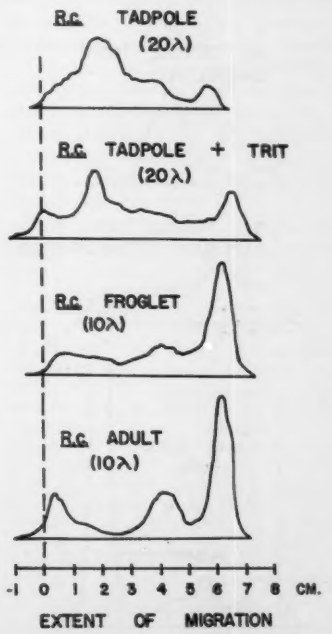

Fig. 1. Paper electrophoresis patterns of the bullfrog (*Rana catesbiana*) at various stages of development. Triiodothyronine-treated tadpoles were injected with 0.010 ml triiodothyronine ($10^{-5}M$) per gram of body weight 4 to 6 days (kept at 23° ± 1°C) prior to bleeding. The volume of serum used is indicated in parentheses.

Table 1. Serum proteins of *Rana catesbiana* at various stages of development.

Stage	No. of animals	Total protein (%)*	A/G†
Young, undeveloped	6	1.01	0.11
Young, triiodothyronine-treated	5	1.74	0.25
Froglet	9	2.56	0.96
Adult	5	2.56	0.86

* Nitrogen in TCA insoluble components × 6.25.
† Derived from electrophoretic patterns.

and other species of frog are being thoroughly studied and will be published subsequently.

The modifications of the serum proteins noted here during tadpole metamorphosis telescope into one species a variety of trends occurring in evolution. The frog is particularly well suited for a comparative study since, in the course of its development, it changes from an aquatic form to a terrestrial form. In addition, genetic and environmental factors can be kept relatively constant for a given species of frog at various stages of metamorphosis. These factors cannot be controlled as well in comparative phylogenetic studies.

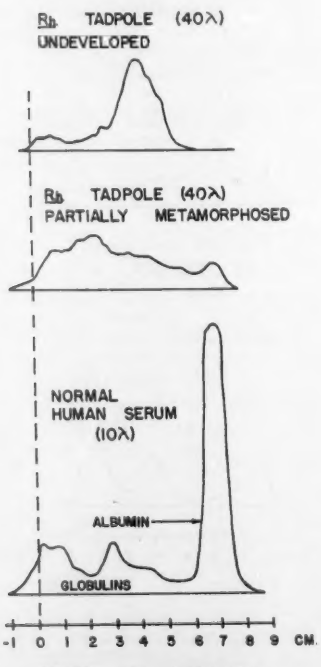

Fig. 2. Comparison of paper electrophoresis patterns of tadpoles of species *Rana hecksheri* with normal human serum pattern.

An examination of the literature on the nature of the serum proteins of widely different animals does not present a perfectly consistent picture on the character of evolutionary changes in the serum protein constituents (*5*). Although exceptions are noted, the increased complexity of animals is usually associated with (i) an increased total protein concentration (*6*), (ii) an increase in the A/G ratio, and (iii) the appearance or great increase in the concentration of a fraction or fractions with very low mobility (*7*) (corresponding to human gamma globulin). Thus, it appears that the tadpole may be reflecting its larval ontogeny with its rapidly changing serum-protein composition.

A teleologic rationale may also be constructed for the increase in A/G ratio and total protein of the tadpole during differentiation. The conservation of the body water and the maintenance of the plasma volume—properties enhanced by high plasma albumin and protein content—are certainly more critical for the terrestrial form. It is noted that a low serum protein concentration is typical of most aquatic animals (*6*).

Finally, the balance between the albumin and globulins seems to be related to the thyroid state of some organisms, with an increase in the A/G ratio as the animal progresses from hypothyroidism to euthyroidism (*8*). The increase in A/G ratio during amphibian metamorphosis might, then, reflect a response of the tadpole to endogenous or exogenous thyroid hormone.

It is hoped that the extensive study, now in progress, of the serum proteins in metamorphosing animals, aquatic forms, and a wide range of phyla will contribute to our understanding of the place of the serum proteins in comparative biochemistry (*9*).

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2. Sterox SE is a polymeric thioether available in experimental quantities from the Monsanto Chemical Company, Boston 49, Mass. The presence of Sterox markedly improves resolution as the result of sharpening the bands in the electrophoretic pattern. It functions as a non-ionic detergent and presumably reduces protein-protein interaction without altering the nature and the charge of the protein molecules. In the presence of Sterox SE, A/G ratios are obtained from the electrophoretic patterns of normal human serum which agree with ratios obtained by sulfite precipitation methods within 2 percent (J. Downs and K. Lunan, private communication).
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13 June 1957

Chlorination of Poliovirus

The inactivation of viruses by chlorination is of interest to sanitarians, since it is the usual method for the disinfection of water supplies and sewage. Although the effects of chlorine on viruses have received their share of attention in the past, quantitative data illustrating rates of inactivation of animal viruses have not been presented. The experiments discussed here indicate that inactivation of poliovirus by chlorine, under the conditions described, may follow a course not strictly linear. When water suspensions of poliovirus were exposed to chlorine for various lengths of time, the change in infectivity titer was not necessarily constant.

Suspensions of polioviruses type 1 (Mahoney), type 2 (MEF_1), and type 3 (Saukett), grown on HeLa cell cultures, centrifuged at low speed, and partially purified to minimize chlorine demand by adsorption onto, and elution from, Dowex-1 resin and dialysis, were added to chlorine-demand-free water, buffered at *p*H 7.0, to give 300 to 10,000 50-percent tissue-culture infectious doses ($TCID_{50}$). They were dosed with chlorine water to yield a free available chlorine residual (at the end of 1 minute at room temperature) of 0.17 to 0.23 ppm. Six-milliliter samples were withdrawn at intervals for determination of residual chlorine, and 1-ml samples, for estimation of infectivity titer. Samples for infectivity titers were added to 0.25 ml of 0.1*N* sodium thiosulfate to stop the action of the chlorine. Infectivity titers were estimated by inoculating HeLa cell cultures, in duplicate, with undiluted or

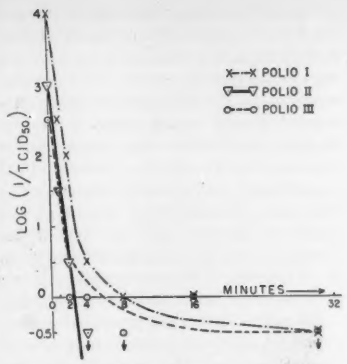

Fig. 1. Infectivity titers of polioviruses at intervals after exposure to chlorine at *p*H 7.0 at 25 to 28°C.

tenfold dilutions of sample and observing them for degeneration over a 6-day period. Residual chlorine was determined as the free available and combined available residuals, by means of the orthotolidine-arsenite method (*1*).

Infectivity titers after exposure to chlorine for various intervals are shown in Fig. 1. The change in titer of poliovirus type 2 was constant, resulting in an inactivation curve that is linear; the change in titer of polioviruses 1 and 3 was constant only during the first few minutes of exposure, resulting in a curve that is linear for the early part of the inactivation only.

The linear response of poliovirus 2 to chlorine in amounts that did not inactivate poliovirus 1 and 3 with similar regularity suggests that the latter are more resistant to chlorine than is poliovirus 2. This is indicated also by the time required for complete inactivation (infectivity titer < 0.0) of the three viruses. From 15 to 30 minutes were required for complete inactivation of polioviruses 1 and 3; 4 minutes were required for poliovirus 2—a time required, under similar conditions (*2*), to inactivate Coxsackie A_2. Whether these differences are characteristic of the virus types tested or are dependent on the particular conditions chosen may be made clear by further studies.

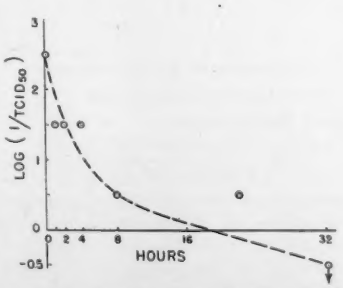

Fig. 2. Inactivation of poliovirus type 1 (Mahoney) by formaldehyde (1/4000 dilution) at *p*H 7.0 at 35°C in chlorine-demand-free water.

The experiments described illustrate the rapidity (in minutes) with which chlorine inactivates viruses in a medium free of other oxidizable substances in comparison with time required (in hours) for inactivation under similar conditions by such common inactivating agents as formaldehyde (Fig. 2). They point out, conversely, and as recorded previously (*2*), that the chlorine residuals found to be sufficient (*3*) for bacterial disinfection are not similarly effective as viral disinfectants.

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1 July 1957

Binding of Histamine and Antihistamine to Bovine Serum Albumin by Mediation with Cu(II)

In the course of our work directed toward the evaluation of physical chemical data regarding protein-histamine-antihistamine interactions (*1*) we have been successful in forming a stable complex, *in vitro*, between copper(II)-bovine plasma albumin and histamine. The Cu(II)-bovine plasma albumin was also found to form a stable complex with the commercial antihistamine, Antistine (*2*).

The physiological role of histamine in allergy has been postulated (*3*) to involve the binding of histamine to a protein; however, recent *in vitro* experiments (*4*) have failed to show any measurable interaction between histamine and a series of purified animal proteins. The complexing of cupric ions to bovine plasma albumin has thus been interpreted as providing a site on the protein capable of binding histamine.

The technique of equilibrium dialysis was used to determine the extent of interaction between the Cu(II)-bovine plasma albumin and the binding molecule, histamine or antihistamine. The protein was crystalline bovine plasma albumin (*5*). The protein was dissolved in a phosphate buffer, placed in Visking 18/32 cellulose casing, and purified by out-dialysis at 0.0°C for 48 hours with the phosphate buffer. This buffer was prepared with reagent grade monobasic potassium phosphate and dibasic potassium phosphate. An ionic strength of 0.2 was maintained throughout the study. Buffer *p*H values of 6.95 and 8.90 could be obtained by using the proper proportions of the buffer constituents. Final protein concentrations were determined by drying aliquot portions of the purified protein solution at 105°C and correcting for the amount of buffer salt.

The copper-proteinate was prepared by adding the purified protein solution to a standard solution of cupric chloride and diluting it with buffer to a known volume. The concentration of copper in the standard solution was determined by electrolytic deposition.

The binding studies were conducted at 0.0°C. Ten milliliters of the copper-proteinate of known concentration was placed in the semipermeable membrane, which was then immersed in 20 ml of ligand solution. These cells were allowed to equilibrate for 24 hours. Simultaneously, blank cells were run in which the membrane contained only buffer, but they were immersed in the same ligand solutions. After equilibration, the difference in concentration between the blank cell and that containing the proteinate was directly proportional to the amount of ligand bound by the proteinate. Histamine concentrations were determined spectrophotometrically by means of a method developed in this laboratory (*6*). Antistine concentrations were determined spectrophotometrically at a wavelength of 240 mμ.

The calculation of the maximum number of moles of a given substance which

Table 1. Interaction of histamine and Antistine with Cu(II)-bovine plasma albumin at 0.0°C. (*A*) Represents the molar concentration of unbound ligand in equilibrium with the proteinate, and *r* represents the moles of ligand bound per mole of proteinate.

$(A) \times 10^5$	*r*	$(A) \times 10^5$	*r*
Histamine, pH 6.95			
4.94	0.273	18.0	0.671
7.06	0.347	19.0	0.980
9.22	0.454	22.4	1.351
13.8	0.621	42.5	6.250
Histamine, pH 8.90			
4.19	0.294	9.31	0.719
6.00	0.460	10.00	0.775
7.35	0.588	14.00	0.877
8.46	0.617	15.30	0.934
Antistine, pH 6.95			
3.03	0.155	10.25	0.357
5.67	0.191	12.14	0.529
7.46	0.253	19.96	0.689
8.04	0.315	22.57	0.917

can be bound to a protein molecule has been completely developed by Klotz (7). This method is based on the law of mass action and assumes that binding occurs in a stepwise fashion, with the first mole bound being held the most firmly. The expression relating moles of small molecules bound per mole of copper-protein complex, r, with concentration of unbound ion (A) is given by

$$r = \frac{m(A)}{K + (A)}$$

Here, K is the intrinsic dissociation constant for the system, and m is the maximum number of bound ions per molecule. In order to evaluate m and K, the equation is rearranged to

$$\frac{1}{r} = \frac{K}{m}\frac{1}{(A)} + \frac{1}{m}$$

A graph of $1/r$ versus $1/(A)$ will be a straight line with the intercept on the $1/r$ axis equal to $1/m$ and the slope of the line equal to K/m.

The results of the binding studies involving histamine at *p*H values of 6.95 and 8.90 and Antistine at a *p*H of 6.95 are shown in Table 1. It was found that these binding data obeyed the law of mass action; that is, the binding increased with an increase in concentration of unbound ligand in equilibrium with the Cu(II)-proteinate.

Extrapolation of the linear plot of the reciprocals of the amount bound versus the concentration of unbound ligand yielded values for the maximum moles of ligand bound per mole of proteinate. These values were 2.75 and 20.0 for histamine at *p*H values of 6.95 and 8.90, respectively. The Cu(II)-proteinate was capable of binding a maximum of 1.74 moles of Antistine per mole of proteinate at a *p*H of 6.95.

The equilibrium constants for the first mole of ligand bound, obtained from the slope of the linear plot, were utilized to determine the free energy change for the formation of the ligand-proteinate complex. These values were −0.871 kcal and −0.910 kcal per mole for histamine at *p*H values of 6.95 and 8.90, respectively, while the corresponding value of Antistine was −0.868 kcal per mole at *p*H 6.95.

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1. Supported in part by grant No. E-1354 from the National Institutes of Health, U.S. Public Health Service.
2. Antistine is the commercial name for 2(N-phenyl-N-benzyl-aminomethyl)-2-imidazoline hydrochloride, which was kindly donated by the Ciba Pharmaceutical Company, Summit, N.J.
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* Submitted in partial fulfillment of the requirements for the degree of doctor of philosophy, Kansas State College.

11 July 1957

Hereditary Ovarian Tumors in Drosophila melanogaster

A recent study has been published which describes normal oogenesis in the fruit fly, *Drosophila melanogaster* (*1*). During this study ovarian tumors were observed. However, the incidence was extremely low (two tumorous chambers among 39,900 developing eggs). It was shown subsequently that ionizing radiation (4000 r of Co^{60} gamma rays) increased the incidence of tumors by 26 times.

In *Drosophila* a developing egg consists of a chamber containing 16 cells. Fifteen of the cells function as nurse cells and nourish the 16th cell (the primary oocyte). All 16 cells arise from a single cell in the germarium, which undergoes four consecutive divisions. It was postulated therefore that, in the region of the germarium where 16 cell cysts are formed, an interaction takes place between cytoplasmic substances localized in this region and the genome of the cells. The stimulated genetic material is thought next to manufacture a substance which inhibits further cytokinesis in a precise fashion. Radiation might occasionally inactivate that portion of the genome of an oogonium responsible for the production of the inhibitor. This mutation would then be passed to the progeny of the oogonium. These cells would now divide in an uncontrolled fashion and produce the observed tumorous chambers which contain hundreds to thousands of mitotically active cells.

We set out to detect mutant genes which would cause such uncontrolled cell division; but we recognized that such genes would be difficult to obtain, since they would generally produce consequences which would be lethal at an early stage in the life-cycle. From our knowledge of oogenesis, it seemed reasonable to predict that some of the genes we were looking for might be found among the 60 or so nonallelic, recessive female sterile mutants of *Drosophila melanogaster*, because uncontrolled division in egg chambers would convert developing eggs to tumors and so sterilize the fly.

We therefore obtained approximately 20 female sterile mutants and proceeded to make Feulgen whole mounts of ovaries of females homozygous for the various female sterile genes (*2*). To our amazement, the first female sterile mutant examined turned out to be a case in point, and the first ovarian preparation contained more tumors than the total we had observed from all sources up to that time. The incidence of tumors was found to increase with the age of the female. In this strain, adjacent chambers in an ovariole often fuse together. If one such chamber is tumorous and the other is normal, there will be produced a compound chamber containing normal and tumorous cells. The actively dividing tumorous cells will subsequently invade the normal tissue of the compound chamber.

This mutant which produces tumors of one tissue at one particular stage in the life-cycle is *fused* (*fu*), discovered by C. B. Bridges in 1912. It is located at 59.5 on the X-chromosome. The allele in question is spontaneous in origin, but alleles induced by x-rays or chemicals have been frequently observed. In our stock (which was obtained from the Yale collection) *fu* is balanced over M5. Females heterozygous for *fu* show no tumors. On the other hand, females homozygous for fu^{ft} (an allele of *fu* induced by formalin treatment) also show ovarian tumors. It appears that *fu*, in addition to its many other bizarre effects (*3*), produces ovarian tumors and therefore represents excellent material for further studies of the mechanism of tumorous growth.

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26 June 1957

Fluorescence of Ethylenediamine Derivatives of Epinephrine and Norepinephrine

In 1952, Weil-Malherbe and Bone introduced a method for the chemical determination of total "epinephrinelike" substances in blood, which included separation of the catechol amines from other plasma components by adsorption chromatography and measurement of the separated fraction by fluorometry (*1*). Shortly thereafter, Persky and Ros-

ton (*2*) published a modification of the fluorometric procedure which made possible the quantitative differentiation of epinephrine and norepinephrine in mixtures, further advancing the hope of developing a practicable chemical method for the assay of these hormones in biological fluids. Subsequent attempts to apply these procedures to the quantitative measurement of epinephrine and norepinephrine in plasma, however, were not uniformly successful, and a variety of modifications have been reported (*3*). In the course of a systematic evaluation of this method in our laboratory, some sources of error have been isolated which may possibly account for some of the difficulties experienced with this procedure.

The coefficients of the equations used to calculate the relative quantities of epinephrine and norepinephrine in a mixture were determined from separate measurements of standard solutions of epinephrine and norepinephrine, a Farrand photoelectric fluorometer, model A, being used to measure the fluorescence. It was found that the ratio of fluorescence of epinephrine to norepinephrine measured in this manner was not in agreement with the values calculated from the emission spectra of the epinephrine- and norepinephrine-ethylenediamine derivatives published by Persky and Roston. The fluorescent emission spectra of these derivatives were therefore investigated.

In these experiments, a Farrand spectrofluorometer (*4*) was used for determining the spectral distribution of fluorescence. Since it was found that the norepinephrine derivative was unstable and that the rate of decay of its fluorescence was a function of the intensity of the exciting wave length, a Corning filter No. 3315, which passes the 436-mμ line, was used to decrease the intensity of the exciting light. The emission spectra of the ethylenediamine derivatives of epinephrine and norepinephrine (*5*) are shown in Fig. 1. The peak emission of the norepinephrine derivative is at 495 mμ, while the peak emission of the epinephrine derivative lies at 525 mμ. The ratio of fluorescence of epinephrine to norepinephrine, measured at 510 mμ, is 0.71, while the ratio measured at 600 is 4.00. These values are in agreement with the ratios determined with the Farrand model A fluorometer, Corning filters Nos. 5113 and 3389 being used in the primary, Corning filters Nos. 5433 and 3384 for the 510 mμ secondary, and Corning filter No. 2418 for the 600 mμ secondary.

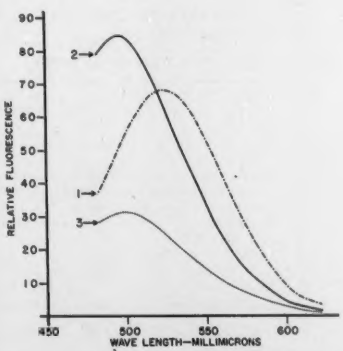

Fig. 1. Fluorescence spectra of epinephrine-ethylenediamine (0.2 μg/ml of isobutanol) and norepinephrine-ethylenediamine (0.2 μg/ml of isobutanol). Exciting wavelength is 436 mμ. Curve 1 is epinephrine; curve 2 is norepinephrine; curve 3 is the reagent blank. [Walter Reed Army Institute of Research]

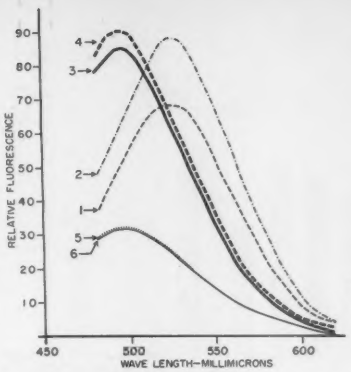

Fig. 2. Fluorescence spectra of epinephrine and norepinephrine condensed with ethylenediamine in acetic acid and in alumina-treated acetic acid. Exciting wavelength is 436 mμ. Curve 1 is epinephrine (acetic acid); curve 2 is epinephrine (alumina-treated acetic acid); curve 3 is norepinephrine (acetic acid); curve 4 is norepinephrine (alumina-treated acetic acid); curve 5 is reagent blank (acetic acid); curve 6 is reagent blank (alumina-treated acetic acid). [Walter Reed Army Institute of Research]

An additional source of error was observed in the procedures used for determining the relative quantities of epinephrine and norepinephrine after these substances have been isolated by adsorption on alumina. A difference was observed in the fluorescence of epinephrine and norepinephrine condensed with ethylenediamine in standard acetic acid solutions as compared with the fluorescence of epinephrine and norepinephrine condensed with ethylenediamine in acetic acid which has been passed over an alumina column. It has been reported that the fluorescence of the epinephrine derivative is 100 to 150 percent greater in the acetic acid treated with alumina (*6*). In Fig. 2 the fluorescence of epinephrine and norepinephrine condensed with ethylenediamine in acetic acid is compared with the fluorescence of epinephrine and norepinephrine condensed with ethylenediamine in acetic acid which has been passed through an alumina column. It can be seen that the intensity of the fluorescence of both the epinephrine and norepinephrine derivatives is increased, the increase for the epinephrine derivative being greater than that for the norepinephrine derivative. It is also evident that there is no proportionate increase in the fluorescence of the reagent blank.

In a range of 0.02 to 0.20 μg, the average increase in the fluorescence of the epinephrine derivative measured at 510 mμ is 30 percent, while the average increase in the fluorescence of the norepinephrine derivative amounts to 9 percent. Figure 2 also indicates that the difference in the spectral distribution of the fluorescence of the derivatives prepared in acetic acid and in alumina-treated acetic acid is of a quantitative rather than a qualitative nature.

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14 June 1957

Bilirubin Glucuronide Formation in vitro; Demonstration of a Defect in Gilbert's Disease

Cole and Lathe (*1*) succeeded in isolating preparations of bilirubin which, free of protein, yielded either direct (immediate) or indirect (delayed) reactions with diazotized sulfanilic acid (van den Bergh reaction). More recently, Billing and Lathe (*2*), Schmid (*3*), and Talafant (*4*) have demonstrated that direct-reacting bilirubin is the glucuronide of bilirubin. A substance present in boiled liver extract, later shown to be uridine diphosphate glucuronic acid (UDPGA), has been found to enhance the formation of glucuronides of various receptors by rat liver homogenate (*5*). An enzyme (transferase) present in the microsomal fraction of rat liver has been shown to

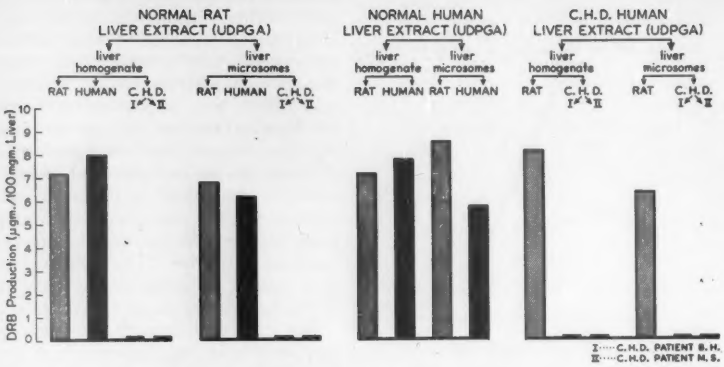

Fig. 1. Direct-reacting bilirubin glucuronide production by liver preparations from normal rats and human beings and from patients with constitutional hepatic dysfunction (Gilbert's disease).

catalyze the transfer of glucuronic acid from UDPGA to various receptors (*5, 6*). On the basis of these observations, an *in vitro* system has been developed which can convert indirect-reacting bilirubin to direct-reacting bilirubin glucuronide.

This system consists of (i) bilirubin, (ii) an extract of human or rat liver which presumably supplies UDPGA, and (iii) a homogenate of human or rat liver, or microsomes prepared from the homogenate. On fractionation of the whole homogenate, virtually all of its transferase activity is found in the microsomal fraction. With this system it has been possible to assay the effectiveness of liver tissue of normal human beings and of patients with constitutional hepatic dysfunction (CHD) in serving as a source of UDPGA and of transferase activity.

The incubation system (*5*) consisted of 0.3 ml of 0.5*M* potassium phosphate buffer (*p*H 7.4); 0.1 ml of 0.3*M* magnesium chloride; either $3.5 \times 10^{-5}M$ commercial bilirubin or $1.4 \times 10^{-4}M$ orthoaminophenol and $10^{-3}M$ ascorbic acid, suspended in 1 ml of 0.4 percent albumin solution. The total volume of each sample was 3.4 ml. Liver extract was prepared from homogenized, freshly obtained human or rat liver, which was gently boiled in isotonic potassium chloride and was subsequently centrifuged. The homogenates of human or rat liver were prepared in nine volumes of isotonic alkaline potassium chloride. Microsomes of human or rat liver were prepared by the Novikoff (*7*) and Schneider-Hogeboom (*8*) procedures, or in a medium of alkaline isotonic potassium chloride. Human and rat liver extracts and homogenates or microsomes were incubated interchangeably with bilirubin (Fig. 1) or orthoaminophenol. Incubation was carried out for 40 minutes at 37.5°C, in room air, at *p*H 7.4. Orthoaminophenol glucuronide was determined by the method of Dutton and Storey (*5*). Direct-reacting bilirubin production was determined by measuring the concentration of the resulting azopigment after centrifugation (*9*) and by subsequent chromatography, as has been described by Schmid (*3*). Mild acid hydrolysis or treatment with beta glucuronidase converted the direct-reacting azopigment to the indirect-reacting azopigment with the liberation of 1 mole of glucuronic acid per mole of converted azopigment. The glucuronic acid was identified by the carbazole reaction (*10*) and by paper chromatography.

Liver tissue was obtained at surgery from normal adults and from two patients with constitutional hepatic dysfunction (Gilbert's disease). The first patient (B.H.) was 21 years of age; the second (M.S.) was 43 years of age (*11*). The serum bilirubin concentrations were 8.8 and 18.8 mg percent, respectively, virtually all of which reacted only indirectly with diazotized sulfanilic acid. Histologic examination of the liver specimens revealed no abnormalities. Bile was aspirated from the gall bladder of the second patient, and its bilirubin was virtually all direct-reacting bilirubin glucuronide.

Figure 1 indicates that normal human or rat liver extract (UDPGA) and normal human or rat liver homogenate or microsomes (transferase) are capable of effecting the conjugation of bilirubin and glucuronic acid. The liver extracts of patients with constitutional hepatic dysfunction can effect conjugation on incubation with normal rat liver homogenates or microsomes. The liver homogenates or microsomes of the patients with constitutional hepatic dysfunction, however, are markedly defective in promoting conjugation on incubation with normal rat liver extract as well as with CHD liver extract. In other studies, no inhibition of bilirubin conjugation by CHD liver homogenates was detected (*12*). The defect in the livers of patients with constitutional hepatic dysfunction resides, therefore, in a deficiency of transferase activity. This deficiency is not limited to bilirubin conjugation, for the formation of orthoaminophenol glucuronide is similarly impaired. The finding of direct-reacting bilirubin glucuronide in the bile of one of the patients with constitutional hepatic dysfunction is perhaps explicable on the basis of a slight degree of transferase activity. The possibility may be raised, however, of an alternate pathway of glucuronide formation in man.

These studies demonstrate that the formation of bilirubin glucuronide in human, as well as rat, liver involves the transfer by an enzyme in liver microsomes of glucuronic acid from uridine diphosphate glucuronic acid to bilirubin. Grodsky and Carbone (*13*) and Schmid (*14*) have shown independently that this mechanism is present in normal rat liver. The deficiency in transferase activity in the liver microsomes of patients with constitutional hepatic dysfunction accounts for the difficulty in the excretion of bilirubin in this disease. An analogous defect is observed in the congenital hyperbilirubinemia of rats (*12, 14, 15*). The defective formation of several other glucuronides in these rats and in patients with constitutional hepatic dysfunction (*14*) is probably ascribable to a deficiency in transferase activity (*16*).

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* Senior research fellow, New York Heart Association.

5 July 1957

Book Reviews

On Human Communication. A review, a survey, and a criticism. Colin Cherry. Technology Press, Cambridge, Mass.; Wiley, New York, 1957. 333 pp. Illus. $6.75.

Civilization, as we know it today, would have been impossible without the evolution of phonetic speech and written language. By means of symbols, man has learned how to transmit and to preserve his ideas and inventions. In this way he has also pierced the barriers of time and space.

Recent advances in communication engineering have created a demand for a critical inventory of our fragmentary knowledge of the field of human communication. The initiative was taken by Massachusetts Institute of Technology, and the task was assigned to an expert who is well known in this country and abroad for his breadth of interest, especially for his mathematical studies. Colin Cherry is the Henry Mark Pease reader in telecommunication at the University of London.

This book, the first of a projected series, is a lucid summary pitched to the needs of "newcomers" in communication theory and calculated to reveal the inherent unity between the diverse facets of the subject: linguistics, sociology, neurophysiology, semantics, philosophy, engineering, psychology, and so on.

Following a definition of current terms, Cherry gives a concise, historical review of the rise of "communication science" (specifically, languages and codes, a review of mathematical theory and scientific method, and a discussion of "Brains—real and artificial." It was heartening to me (a social psychologist) to note the author's clarity on this point. The layman has been grossly misled recently by much journalistic humbug eulogizing "electronic brains." Says Cherry: "The inaccessibility and complexity of the central nervous system and of the brain render direct analysis overwhelmingly difficult; the brain may contain more than 10^{10} nerve cells, whereas the most complicated computing machine has only some 10,000 relay units. . . ." (page 60).

Equally refreshing is the treatment of "Signs, language, and communication," in which Cherry appears to be as familiar with the work of such theorists as Carnap (semantics, symbolic logic) and Sapir (linguistics) as with the authorities in his own specialty—the physical analysis of signals, including speech.

The hard core of the book deals with statistical communication theory and the related body of empirical knowledge which, since it rests upon "a solid foundation of mathematics," eludes popularization. The treatment of the relevant topics is limited and is intended chiefly as a guide to the literature of the subject.

Under "Logic of communication," the author presents a miscellany of useful, albeit unrelated, topics. His allusions to John Locke's theory of signs, "semiotic," with its three levels—syntactics, semantics, and pragmatics—and to the little-known work of Charles Peirce and his pragmatic philosophy of signs are very illuminating.

Finally, Cherry reenters the psychological field and deals cursorily with the topics cognition and recognition and with the search for invariants. He concludes his survey with the sound deduction that man is distinguished from the animals by reason of (i) the scope and organization of his concepts and (ii) his capacity to communicate with the aid of language.

This volume fills a long-felt need for a synthesis of the theoretical and empirical knowledge of the field. The bibliography of 367 titles is indicative of the book's broad scope. The design of the study is admirable, and the execution is superb. Moreover, the book itself is, indeed, a model of human communication.

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Galactic Nebulae and Interstellar Matter. Jean Dufay. Translated by A. J. Pomerans. Philosophical Library, New York, 1957. 352 pp. $15.

In 1926, A. S. Eddington of Cambridge University presented before the Royal Society of London an epoch-making Bakerian lecture in which he revived the old and almost forgotten hypothesis of J. Hartmann that interstellar space is filled with clouds of calcium atoms and placed it on a solid foundation of theoretical reasoning. Four years later, R. J. Trümpler at Lick Observatory and C. Schalén in Uppsala established the existence in interstellar space of vast clouds of small, scattering, solid particles which weaken the light of distant stars and cause it to appear redder than would be the case if space were transparent. Since then, an enormous amount of work has been done on the properties of the interstellar medium. Th. Dunham and I established, both theoretically and by means of observations, that hydrogen is the most abundant element in interstellar space and that many large areas of the Milky Way emit a faint glow in the red line of hydrogen alpha. B. Strömgren developed his famous theory of ionized (H II) and un-ionized (H I) regions in the galaxy and deduced their average densities and temperatures. W. A. Hiltner and J. S. Hall discovered the polarization of the transmitted light of distant stars, while J. L. Greenstein and L. Davis explained this effect theoretically as a consequence of a preferential orientation of the crystallike interstellar particles by a large-scale magnetic field, of the order of 10^{-5} gauss. E. Fermi and S. Chandrasekhar had assumed the existence of such a field in order to explain some of the properties of cosmic rays. L. Spitzer, Jr., at Princeton, and his pupils, investigated the cosmogonical effects of the diffuse interstellar medium, while J. H. Oort and H. C. van de Hulst in Leiden pioneered in the field of radio-observations, especially of the 21-cm line of hydrogen, which has given new and wholly unexpected results in several fields of astrophysical research.

Galactic Nebulae and Interstellar Matter is a translation from the original French edition of 1954, with certain minor revisions that bring the text up to date (to 1955). The author states that the book is intended both for the professional astronomer and for the layman interested in astronomy. He has certainly succeeded magnificently with regard to his second objective: the style is easy, and the reader (who must have some modest amount of knowledge of physics) is taken step by step from one intriguing problem to another. But the professional astronomer may find the book somewhat lacking in the most recent developments, such as the discovery of "synchrotron radiation" in the Crab nebula, the origin of cosmic rays, the interaction between stars and nebulae, and so forth.

The translator has, on the whole, succeeded in retaining the delightful style of the French original. But, unfortunately, he has used many strange and often misleading expressions by translating too literally the original French words: the term *Schmidt chamber* (page 112) sounds strange in English, and there are many more instances of the same

kind. A serious reader will also be disappointed at the amazing number of misspelled names: "Pearse" instead of "Pearce," "Osterbrok" instead of "Osterbrock," "Matsukov" instead of "Maksutov," and so on.

The book consists of an introduction ("Some fundamental ideas of astrophysics") and of 19 chapters, arranged in four parts: (i) "Atoms and molecules in space," (ii) "Solid particles in space," (iii) "From atoms to grains and from grains to stars," and (iv) "Diffuse matter outside the Milky Way."

In conclusion, it is appropriate to mention that Dufay's own research has had a considerable influence on the development of the ideas discussed in his book. Thirty years ago he investigated the relative contributions to the diffuse light of the night sky of the "air-glow," of resolved and unresolved stars, of starlight scattered by interstellar particles, and so on. His most recent work with infrared-sensitive photographic emulsions and suitable light filters has demonstrated the relatively much greater transparency of space in infrared light than in ordinary blue or violet light.

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Analytical Microscopy. Its aims and methods in relation to foods, water, spices, and drugs. T. E. Wallis. Little, Brown, Boston, Mass., ed. 2, 1957. 215 pp. Illus. $5.50.

For many years, fortunate was the microscopist who had access to T. E. Wallis' little book. Now we can all have a copy that is twice as large and has twice the number of illustrations, plus two appendixes—one of numerical data on seed weights, vein-islet numbers, leaf palisade ratios, stomatal numbers, pollens, and drug powders and the other on formulas for useful stains and reagents. The bibliography is modernized, and the author is now listed as a member of the Society for Analytical Chemistry rather than of the Society of Public Analysts.

The materials examined are foods, drugs, fibers, mineral substances, and water. Measurement, drawing, and quantitative methods are described and discussed by an old master. Clear drawings are given to aid in identification of starches, plant fragments, insects, and other contaminants associated with these products. There are many numerical data on the sizes of botanical materials.

The outstanding advantage of this book, in my opinion, is the description and discussion of the basic methods of preparing a sample and of procedures for examination with the microscope. The book is practical, is largely based on the author's broad experience as a microscopist, and considers problems that are not solvable by chemical methods alone. The professional microscopist will gain more from the book than will those working in a limited field, although any student who has to use a microscope will benefit from browsing among these chapters. By some, methods which do not include ultrathin sectioning, and so on, will be considered old-fashioned; others will agree with Wallis that shrinkage and distortion should be avoided whenever possible.

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A Monograph of the Immature Stages of African Timber Beetles (Cerambycidae). E. A. J. Duffy. British Museum (Natural History), London, 1957. 338 pp. + plates. £5 5s.

This is the second in a proposed series of monographs on larvae of timber beetles. It corresponds in format and presentation to the previous volume. Species from Madagascar and other neighboring islands are included, in addition to those from Africa. Readily workable keys are presented, which make possible for the first time the identification of "all species of major importance."

Significant morphological characters are adequately described and often clearly illustrated, and there are ten plates of excellent black-and-white photographs showing typical damage. Information on biology, hosts, and distribution and often on parasites or predators is made available, much of it for the first time. A remarkably complete bibliography of significant papers is presented.

W. H. ANDERSON
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The Granite Controversy. Geological addresses illustrating the evolution of a disputant. H. H. Read. Interscience, New York, 1957. xix + 430 pp. Illus. $6.75.

The Granite Controversy brings together eight addresses by H. H. Read, delivered between 1939 and 1954, all on the controversial topic of the origin of granite. Some of the earlier of these addresses were not widely distributed because of war conditions; in any event, this republication in a single volume is very useful. Anyone who has had the privilege of hearing Read speak does not have to be told of the vigor of his prose or of his humor and his skill in debate. The book is well written, with life and verve, and, even though from the nature of the material there is considerable repetition, it is a pleasure to read.

No one could consider the book an objective weighing of the evidence—in fact, the author freely admits his bias toward granitization rather than toward a magmatic origin for granite. To him, all granite masses are members of a "granite series," to be traced from one geologic environment to another, through time. Their associated rocks and structural relations vary widely but can be considered to form a consistent pattern. In regionally metamorphosed terrains, many bodies are derived from essentially undisplaced sedimentary or volcanic rocks. Emanations from the mantle have introduced silica, potassa, alumina, and other substances to produce a metamorphic aureole, passing inward from schist, through gneiss, to migmatite, and finally to granite. The material of the granite mass was hot enough and had enough interstitial fluids to flow readily, yet it was never molten. Owing to its plasticity and low density, orogenic stresses cause some of the material to rise, so that it ultimately comes, in part, to occupy spaces far distant from, and at shallower levels than, the site of the transformation of the parental rocks. These cross-cutting granites have contact aureoles of the Barr-Andlau type that have led to the idea that granites have been derived from molten rock or magma. Although they are traveled bodies, their origin, like that of the granites of metamorphic terranes, lay in the transformation of older rocks. Parts of these cross-cutting bodies may have been molten, but the bulk was probably crystalline throughout time, so that the emplacement was of a crystal mush.

Read's disarming preface emphasizes the undoubted fact that the origin of granite clearly took place under conditions not susceptible of laboratory duplication and states that therefore field evidence should control our theory of origin. The interpretation put on identical field relations by different geologists will necessarily vary with their individual experiences. Geologists working in nonmetamorphic terranes have naturally differed in their inferences from those working in regionally metamorphosed rocks. The idea of magmatic granite has arisen in nonmetamorphic regions. Clearly, Read's experience has been chiefly among the regionally metamorphosed rocks.

Read's conclusion that granites have not arisen, in general, by crystal fractionation of a basaltic magma—the theory to which Bowen's name is inseparably attached—will probably be accepted by most field geologists. There simply are not the vast quantities of intermediate intrusive rocks that this theory demands. Read's insistence on a distinctly

different origin is persuasive, and to me, compelling. But when he goes on to argue (page 155 and elsewhere) that the existence of abundant lavas of granitic composition is irrelevant to the question of the existence of a granitic magma, he seems to write a lawyer's brief. It is as much as to say that basaltic lavas do not prove the existence of a basaltic magma. Despite this bias, there are pages in which Read grants that the second variety of "granites" of his "Granites and granites" dichotomy may, indeed, be partly magmatic. This admission seems to render unnecessary the strained logic that considers glassy siliceous lavas irrelevant to the question of molten siliceous magmas, potentially sources of magmatic granite.

Space limitations preclude an elaborate discussion of the arguments. Every geologist interested in petrology and metamorphism will find much of interest in the book. The discussion of metamorphic facies, of the depth factor in metamorphism, of the migmatite and basic fronts, and of many other topics are of great interest and value. Not the least merit of the book is its review of the long history of the granite controversy. But the modern papers cited seem to have been selected mainly because they support the author's thesis, and far too many of them are quite unconvincing even to a rather sympathetic reader. In the American literature cited, one looks in vain for field reports by Lindgren, Knopf, Larsen, or Buddington; the question of stoping is cavalierly dismissed without reference to Barrell, Daly, Butler, or Loughlin. Similar bias is shown throughout.

The book thus seems to me to present an attorney's brief for the transformist position. That position seems strong enough not to require shoring up with so many ex parte arguments. If ultrametamorphism can produce a migma, as most field men will grant, there is nothing incredible about the further step of complete melting, even though it has not been proved. Nor would the concession of the existence of granitic magma or of stoping in some places disprove, or even weaken, the arguments for transformation in other locales. Not every problem in plutonic geology must have a single solution, nor must one accept as final the progress reports of 1957. At least, the author has not gone over to the dry diffusionists!

No one can read Read's stimulating review without perceiving some fruitful new relationships. Read is a scholar and an experienced and thoughtful field man. His book is recommended to every "hard-rock" geologist, however dangerous it might be to the uncritical.

JAMES GILLULY

U.S. Geological Survey

The Aleut Dentition. A correlative study of dental characteristics in an Eskimoid people. Coenraad F. A. Moorrees. Harvard Univ. Press, Cambridge, Mass., 1957. 196 pp. Illus. $4.50.

Coenraad Moorrees asks how useful the dentition is for the classification of races and specifically whether the characteristics of the teeth distinguish eastern from western Aleuts. These questions are only partially answered. Instead, he reports a survey of the teeth of 156 living Aleuts (all those available), a review of racial odontology, and a series of hypotheses for future study. In dental morphology the Aleuts resemble other Eskimos and Mongoloids. Eruption of teeth is precocious, by European standards. Lower jaws sometimes jut; they never recede. Dental decay has greatly increased following a change in the diet.

The author of the monograph is cautious in his interpretive sallies. His meticulous work therefore awaits further exploitation by other students of genetic and environmental factors in dental variation and disease.

GABRIEL WARD LASKER

Wayne State University

The Principles of Heredity. Laurence H. Snyder and Paul R. David. Heath, Boston, Mass., ed. 5, 1957. xi + 507 pp. Illus. $6.25.

This is the fifth edition of Snyder's well-known textbook pertaining to heredity. Like its predecessors, it is written in a simple and direct style. It should serve well any introductory college course in genetics. Its new features are primarily its format and its new sections, on pseudoallelism, on DNA, and on bacterial genetics. Unfortunately, it was published too early to include the recent evidence that the Y-chromosome of man may not carry as many genes as was previously thought. The chapter on human blood groups and their nomenclature has been brought up to date. Many new problems have been included.

HERLUF H. STRANDSKOV

University of Chicago

New Books

A History of Industrial Chemistry. F. Sherwood Taylor. Abelard-Schuman, New York, 1957. 483 pp. $7.50.

Laboratory Experiments in College Physics. Cicero Henry Bernard. Ginn, Boston, Mass., ed. 2, 1957. 335 pp. $4.25.

Medical Writing. The technique and the art. Morris Fishbein. Blakiston Div., McGraw-Hill, New York, ed. 3, 1957. 272 pp. $7.

Morphological Astronomy. F. Zwicky. Springer, Berlin, 1957. 303 pp. DM. 49.60.

Sir Isaac Newton's Mathematical Principles of Natural Philosophy and His Systems of the World. Translated into English by Andrew Motte in 1729. The translations revised and supplied with a historical and explanatory appendix by Florian Cajori. University of California Press, Berkeley, 1947. 715 pp. $6.50.

The North American Deserts. Edmund C. Jaegers. Stanford University Press, Stanford, Calif., 1957. 318 pp. $5.95.

Principles of Plant Pathology. E. C. Stakman and J. George Harrar. Ronald, New York, 1957. 592 pp. $8.

The Teaching of Hygiene and Public Health in Europe. A review of trends in undergraduate and postgraduate education in 19 countries. WHO Monogr. Ser. No. 34. F. Grundy and J. M. Mackintosh. World Health Organization, Geneva, 1957 (order from Columbia University Press, New York 27). 254 pp. $5.

Antarctic Hazard. Ross Cockrill. Philosophical Library, New York, 1957. 230 pp. $4.75.

An Approach to Modern Physics. E. N. da C. Andrade. Doubleday, Garden City, N.Y., 1957. 266 pp. Paper, $0.95.

Basic Mathematics for Radio and Electronics. F. M. Colebrook and J. W. Head. Iliffe, London; Philosophical Library, New York, ed. 3, 1957. 359 pp. $6.

Beyond Freud. A creative approach to mental health. Camilla M. Anderson. Harper, New York, 1957. 288 pp. $4.

Colorimetric Analysis. vol. I, *Determinations of Clinical and Biochemical Significance.* Noel Allport and J. W. Keyser. Chapman & Hall, London, ed. 2, 1957. 424 pp. $9.

The Computing Laboratory in the University. Preston C. Hammer, Ed. University of Wisconsin Press, Madison, 1957. 236 pp. $6.50.

Craig and Faust's Clinical Parasitology. Ernest C. Faust and Paul F. Russel; assisted by David R. Lincicome. Lea & Febiger, Philadelphia, ed. 6, 1957. 1078 pp. $15.

Dairy Bacteriology. Bernard W. Hammer and Frederick J. Babel. Wiley, New York; Chapman & Hall, London, ed. 4, 1957. ix + 623 pp. $9.

Electron Microscopy. Proceedings of the Stockholm Conference, September 1956. F. S. Sjostrand and J. Rhodin, Eds. Academic Press, New York, 1957. 366 pp. $17.50.

From Sterility to Fertility. A guide to the causes and cure of childlessness. Elliot E. Philipp. Philosophical Library, New York, 1957. 120 pp. $4.75.

Glass Reinforced Plastics. Phillip Morgan, Ed. Iliffe, London; Philosophical Library, New York, ed. 2, 1957. 291 pp. $15.

The Human Brain. From primitive to modern. A. M. Lassek. Thomas, Springfield, Ill., 1957. 250 pp. $4.75.

Lens Materials in the Prevention of Eye Injuries. Arthur H. Kenney. Thomas, Springfield, Ill., 1957. 73 pp. $3.50.

Medical Radiation Biology. Friedrich Ellinger. Thomas, Springfield, Ill.; Blackwell, London; Ryerson, Toronto, 1957. 978 pp. $20.

Meetings and Societies

AAAS Indianapolis Meetings, 1871–1937

The 124th meeting of the American Association for the Advancement of Science this coming 26–30 Dec. is also the fourth Indianapolis meeting. The previous meetings in this key industrial center of the Midwest were held in 1871, 1890, and 1937. A brief comparison of the meetings not only indicates the growth of the AAAS—and of the societies that participate—but also provides an indication of the shifts in emphasis in scientific research. The development of the city and of the nation over 86 years is indicated, and the influence of the times and of the personalities of the past is reflected in the programs and proceedings of these earlier conventions. A number of members who attended the third Indianapolis meeting of 1937 will be in a position to make their own comparisons of the changes that 20 years have brought.

The first Indianapolis meeting, 16–22 Aug. 1871, was held relatively early in the long history of the association. It was only the 20th AAAS meeting, since there had been no meetings during the war between the North and the South. Before this there had been only one convention west of Ohio—the Chicago meeting of 1868.

When the proceedings of this meeting of 86 years ago are read, it is at once apparent that great changes in industry, in transportation, and in the growth of the nation, and at least equally great developments in science, have occurred. In 1871, the population of Indianapolis, exclusive of suburbs, was 48,000—about one-tenth of what it is today. AAAS membership at that time was only 537; it has since increased 100-fold. For inland transportation, railroads were the only large carriers of freight and people. The railroads were relatively prosperous and in a phase of expansion. The use of steel rails and the spread of the Bessemer process of steel production were shortly to come. Then, as now, Indianapolis was a key center of the state and of the region. Indeed, every 24 hours, eighty trains stopped at the Union Depot. In that halcyon period, when hospitality could be abundant and convention visitors could often send free telegrams, two of the 12 railroads that passed through the city invited the 196 AAAS registrants and their families to ride free on excursions to Terre Haute and to the Mammoth Cave in Kentucky. On the first of these trips, time was allotted for free refreshments at Knightsville and for a longer stop-off at Brazil, Ind., to inspect the coal and iron operations there and to partake of a bountiful dinner generously contributed by the townspeople. The city of Terre Haute entertained the delegates overnight, after a reception and addresses. At the close of the meeting, the citizens of Louisville and the Louisville and Nashville Railroad provided complimentary meals on the Mammoth Cave trip.

The technical sessions, at which 107 papers were read before the (then) two sections—A–Mathematics, Physics, and Chemistry and B–Natural History (geology, zoology, botany, ethnology)—were held in the legislative chambers of the State House. The larger general sessions and social events were accommodated in the Academy of Music. General chairman of the first Indianapolis meeting was the Honorable Daniel Macauley, who headed a local committee of 95 members. At the committee's formal reception of the association, on the first afternoon, Governor Conrad Baker gave a brief address of welcome. This was responded to by retiring president Thomas Sterry Hunt, a prominent geologist and charter member of the association, who had succeeded astronomer-mathematician William Chauvenet following the latter's death in office. A tribute was paid to the pioneer scientific work of William McClure and of the Owens, of Indiana's New Harmony community. Hunt's AAAS presidential address the same evening was a scholarly, historical review of the crystalline rocks of the Appalachians. Immediately afterward, Asa Gray, eminent botanist and also a charter member of the association, assumed the presidency of the first Indianapolis meeting.

In the last part of the 19th century, the emphasis in science was still on the descriptive, rather than on the experimental, aspects. Two of the longer papers, for instance, were "On the geological history of the Gulf of Mexico," by E. W. Hilgard (Oxford, Miss.), and "On the characteristics of primary groups of the class of mammals," by Theodore Gill (Washington, D.C.). Among the several resolutions passed at the business meetings were recommendations that the geologic survey of Missouri be published and that the Niagara Falls area be resurveyed.

After an interval of 19 years, the second Indianapolis meeting was held 19–26 Aug. 1890. As in 1871, sessions were held principally in the State House, which had been rebuilt. Nearby, the Soldiers and Sailors Monument, a dominant feature of the center of the city, was in process of erection. Indianapolis had grown to be a city of 105,436 and now had 15 railroads; the membership of the AAAS had increased more than threefold, to 1944, and the number of sections had increased from two to eight.

Ten local committees, responsible for virtually all phases of the meeting, were headed by George W. Sloan, general chairman. Lieutenant Governor Ira J. Chase and Mayor Thomas L. Sullivan welcomed members of the association to the state and city. Social events were numerous and pleasant. At Woodruff Place, one evening, General Lew Wallace, author of *Ben Hur*, addressed the visitors. An excursion was made to the natural-gas region of Indiana, the site of many diversified industries.

This 39th meeting of the association was under the presidency of Asa Gray's successor in botany at Harvard University, George Lincoln Goodale. The AAAS presidential address of retiring president T. C. Mendenhall, well-known physicist, on "The relations of men of science to the general public," would, in part at least, be not inappropriate for the present time. Mendenhall noted that AAAS meetings not only have served scientists but have brought them into closer relations with the public. He found, however, "that the relation between men of science and the general public is not what it should be in the best interest of either or both." Mendenhall said that the viewpoint of the layman "now and then [is] tinctured with contempt for men who devote their lives and energies to study and research, the results of which cannot always be converted into real estate or other forms of taxable property." Conversely, he pointed out that a number of scientists are unable or unwilling to present the results of their work to the intelligent public in understandable language; that men of science may assume superior wisdom on subjects outside their specialties; and that the interest of the scientist in public affairs should not be less than that of other men. Mendenhall observed: "It is generally recognized that, aside

from all questions of a partisan political nature, this country is today confronted by several problems of the utmost importance to its welfare, to the proper solution of which the highest intellectual powers of the nation should be given."

There were 364 registrants, from 30 states, the District of Columbia, and Canada and from several foreign countries at this meeting. Some 213 papers were read. Each of the eight sectional vice presidents gave an address. The following list indicates the subjects of interest to each discipline at the time: A–Mathematics and Astronomy, Seth Carlo Chandler, "The variable stars"; B–Physics, Cleveland Abbe, "A plea for terrestrial physics"; C–Chemistry, Robert B. Warder, "Recent theories of geometrical isomerism"; D–Mechanical Science and Engineering, James E. Denton, "History of attempts to determine the relative value of lubricants by mechanical tests"; E–Geology and Geography, John C. Branner, "The relations of the state and national geological surveys to each other and to the geologists of the country"; F–Biology, Charles Sedgwick Minot, "On certain phenomena of growing old"; H–Anthropology, Frank Baker, "The ascent of man"; I–Economic Science and Statistics, J. Richards Dodge, "The standard of living in the United States."

This last address may be of considerable historical interest. In 1890, the American standard of living, Dodge found, was the highest known—with "no barriers to wealth or station which capacity and persistence cannot sweep away." Statistics were cited on the consumption of meat and other foodstuffs, which was conspicuously higher than elsewhere in the world. There was a parallel high consumption of wool and other textiles, Wages were 50 to 300 percent above those of any other country. Because of surpluses, prices for farm crops were not always satisfactory to the farmers. The question of whether such prosperity could continue was considered, and the speaker concluded that it could, provided that production commensurate with the rapidly growing population could be maintained.

Among the numerous items of business transacted, Section C lent its help to effect a consolidation of the 14-year-old American Chemical Society, then based in New York, with other groups of chemists to form an enlarged and truly national society. A resolution was passed by the council urging the U.S. Department of the Interior to take action to preserve tracts of sequoias in California. The council appropriated $250 from research funds to assist E. W. Morley and H. T. Eddy to continue their investigation of the velocity of light in the magnetic field.

The third Indianapolis meeting, 27 Dec.–1 Jan. 1937–38, was in marked contrast to the two previous meetings in that city. It was much larger and more complex. With some 30 societies holding their national meetings and with the sections of the AAAS by this time numbering 15, there were 3094 registrants, from every state except Nevada and Vermont, and the total attendance was estimated at 5000. A total of 1681 papers were given, in 225 technical sessions in 48 rooms and three laboratories, and the general program was 273 pages in length. AAAS membership had increased to 18,776, and the city's population was approaching 400,000.

In its general organization the 1937 meeting was typical of those of the present day, and it stands as 11th in size of all the 123 AAAS meetings to date. A substantial number of those who attended that meeting, and some who helped with it, will be present at this year's meeting, 20 years later. To mention but a few: Paul B. Sears, this year's retiring president of the association, read two papers, in botany and ecology; Thomas Park and Chauncey D. Leake, other current AAAS board members, read papers before the Ecological Society of America and Section L, respectively, and the latter also presided at a session as president of the History of Science Society. By a coincidence, Stuart A. Rice was vice president for Section K–Social and Economic Sciences—an office in which he is again serving at this year's meeting. A. W. Tucker, Isaac Schour, and Robert C. Anderson, current vice presidents for Sections A–Mathematics, Nd–Dentistry, and Np–Pharmacy, respectively, all read papers in 1937. Joseph J. Cripe, manager of the Indianapolis Convention Bureau, who served as chairman of the printing committee 20 years ago, has been an invaluable consultant this year and again is a member of local committees.

General chairman of the third Indianapolis meeting—the 101st meeting of the association—was Stanley Coulter; the Executive Committee was composed principally of the chairmen of the eight special committees. The president of the AAAS was George D. Birkhoff, eminent professor of mathematics at Harvard University. The association's "permanent secretary" was F. R. Moulton, and the details of the meeting were the responsibility of Sam Woodley, F. C. Brown (exhibits), and Austin H. Clark (press service). As will be the case at this year's meeting, the AAAS main registration was at the Murat Temple, and the Claypool Hotel was AAAS headquarters. Other sessions were held in the same principal downtown hotels in which sessions are scheduled this year. In his report of this 1937 meeting, Moulton wrote: "It is quite possible that . . . [it] will be remembered as the beginning of a new era in the Association because of the increasing sense of responsibility of scientists to society. . . . The opinion was frequently expressed that in integrating the sciences—physical, biological, and social—and in examining the relations of all of them with society, the Association is rendering its greatest service to science and to the world."

The AAAS presidential address of the retiring president, Edwin G. Conklin (emeritus professor of biology of Princeton University), entitled "Science and ethics," was consistent with this emphasis. Conklin took issue with specialists who maintain that science has no concern with ethics and made the point that any program for human welfare needs both areas of human thought. He observed: "Neither in human nature nor in social relations has progress kept pace with science. That is not the fault of science but rather of man and of society. The great advances in the applications of science have often been used for selfish purposes rather than for social welfare. . . . The fact is that social progress has moved so much slower than science that one might say that scientific progress is matched against social stagnation. Many thoughtful persons are asking: 'Will science, which has so largely made our modern civilization, end in destroying it?' " Conklin concluded that education in ethics and in human values is the chief hope of human progress and that men must live up to the best that they know. The AAAS presidential reception that followed was given by the local committee, with Mr. and Mrs. Eli Lilly at the head of the receiving line.

Among other highlights of the third Indianapolis meeting were the 16th Sigma Xi address, "Biological applications of surface chemistry," given by General Electric's Irving Langmuir, subsequently 94th president of the association, and the third Phi Beta Kappa address before the AAAS—"Shakespeare and the critics," by George Lyman Kittredge of Harvard University. This latter was preceded by a performance of Tschaikowsky's fourth symphony, by the Indianapolis Symphony Orchestra. A public lecture on "Syphilis as a public health problem" by Thomas Parran, Jr., Surgeon General, was the climax of a six-session symposium on the subject sponsored by Section N.

Among the many hundreds of short papers given at the 1937 meeting was one on the fine structure of television images and another that pointed out that automobile drivers under 25 years of age were responsible for 20 percent of the nearly 40,000 highway fatalities each year.

The Annual Exposition of Science, 13 years of age as an organized, integral part of AAAS meetings, had 69 exhibits, 34 of them commercial.

The 15th AAAS Newcomb Cleveland prize was awarded to Philip R. White for his paper "Root pressure: an unappreciated force in sap movement," read before the Botanical Society of America. The winner of the first Theobald Smith award, given annually by Eli Lilly and Company, was Robley D. Evans, then at Massachusetts Institute of Technology, for his studies of radium poisoning.

In summary, the records of the three previous meetings in Indianapolis succeed in conveying the warm spirit of hospitality and interest in the work of the association shown by the people of this great community of the Midwest.

RAYMOND L. TAYLOR
Associate Administrative Secretary

IGY Satellite Meeting at NAS

The National Academy of Sciences will be host to an international conference on rocket and earth satellite programs for the International Geophysical Year, 30 Sept.–5 Oct. The conference was called by the Special Committee for the International Geophysical Year (CSAGI), located in Brussels, Belgium. The meeting will bring together delegates from the national IGY committees that are participating in research rocket programs, satellite launching programs, and setting up stations for tracking and observing the scientific earth satellites during the Year. Chairman of the conference is L. V. Berkner, president of Associated Universities, New York, and the IGY committee's reporter on rockets and satellites. This is the first international conference on the IGY to be held in the United States.

Affirmative answers, indicating that delegates will attend the conference, have so far been received from the national committees of Australia, Canada, Great Britain, Iran, Japan, Peru, and the U.S.S.R. A tentative agenda includes discussion of the satellite ground tracking and observation program; the problem of communications in connection with the ground tracking and observation programs; the interchange of data from rocket and satellite experiments; and a discussion of the scientific experiments in the rocket and satellite programs.

Public Health

Reports on a wide variety of research projects aimed at protecting and advancing people's health will be highlights of the 5-day 85th annual meeting of the American Public Health Association and meetings of 40 related organizations in Cleveland, Ohio, beginning 11 Nov. The sessions are expected to attract more than 5000 public health workers from throughout the Western Hemisphere. Of about 400 scientific papers to be presented in 75 sessions, more than half will be reports on research accomplishments or opportunities.

Considerable interest is expected to center around a session on radiation protection. The session will include a symposium on current status in setting radiation exposure standards; a scientific paper on community health problems resulting from peacetime uses of radiation, to be presented by Roy J. Morton, associate director of the radioactive waste disposal research project at Oak Ridge National Laboratory and president-elect of the association; and a paper on program planning for radiation protection, to be presented by Herman E. Hilleboe, New York State health commissioner, and Alexander Rihm, Jr., chief of the radiological health section of the New York State Department of Health. Another session of timely interest will be a panel discussion on influenza, including epidemiology, status of vaccine production and utilization, control measures, and laboratory services.

One of the general sessions scheduled will feature addresses by the association's president, John W. Knutson, assistant surgeon general and chief dental officer of the U.S. Public Health Service, and Lowell J. Reed, president emeritus of Johns Hopkins University. Another general session is the closing symposium, which will be devoted to public health priorities for 1958.

Neutron Interactions

More than 150 outstanding nuclear physicists representing the United Kingdom, the U.S.S.R., France, India, Japan, Italy, Sweden, Germany, Norway, Denmark, the Netherlands, and the United States met 9–13 Sept. at Columbia University to participate in the International Conference on the Neutron Interactions with the Nucleus. I. I. Rabi, Higgins professor of physics at Columbia and Nobel Prize winner, presided over the conference, and W. B. Lewis, vice president of Atomic Energy of Canada, Ltd., served as vice president. The many distinguished participants included Homi Bhabha of India and Francis Perrin of France.

The meeting was held under the auspices of the International Union of Pure and Applied Physics. In addition to the host, Columbia University, the sponsors were the U.S. Atomic Energy Commission, the Office of Naval Research, and the Air Force Office of Scientific Research.

Geneva Station's 75th Anniversary

"The role of agriculture in future society" will be the theme of a 75th anniversary symposium at Cornell University's New York State Experiment Station in Geneva, N.Y., on 4 Oct. Governor Averell Harriman will address the assembly and will break ground for a food science building and pilot plant. Willard F. Libby, member of the Atomic Energy Commission, will lead a discussion on trends in scientific research in agriculture and their probable impact upon future society. The sessions will be open to the public.

Fauna of the Soil

During the sixth International Congress of Soil Science at Paris in 1956, zoologists specializing in the study of the fauna of the soil formed an international group with the object of providing a means for the exchange of information among workers in this field. To achieve this object, a news bulletin is being published, and, in addition, international colloquia on particular aspects of the subject will be held at intervals.

The first number of the bulletin was published in May; it includes a questionnaire requesting details of current research projects, together with information of animal groups studied. The results of this inquiry will be reported in future numbers of the bulletin. Anyone interested in this field of research and who has not received the bulletin may obtain a copy by writing to Mr. J. d'Aguilar, Station centrale de Zoologie agricole, Route de St-Cyr, Versailles, France.

The first colloquium, Methods of Research in Soil Zoology, will be held at Rothamsted Experimental Station, Harpenden, Herts., England, 10–14 July 1958, immediately prior to the International Zoological Congress to be held in London. The news bulletin provides the program and other details of the colloquium.

Forthcoming Events

October

20–22. American College of Apothecaries, St. Louis, Mo. (R. E. Abrams, Hamilton Court, Chestnut and 39 St., Philadelphia, Pa.)

20–27. International Soc. of Surgery, 17th cong., Mexico, D.F., Mexico. (P. Martin, ISS, 141, rue Belliard, Brussels, Belgium.)

21. Air Pollution Symp., 2nd annual, Philadelphia, Pa. (A. D. Hollingsworth, Franklin Inst., Benjamin Franklin Parkway at 20th, Philadelphia 3.)

21–25. Medical Aspects of Workmen's

Compensation, New York. (Office of Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16.)

21–26. Ultra High Frequency Circuits and Antennas, internatl. conf., Paris, France. (Congrès Circuits et Antennes Hyperfréquences, Société des Radioélectriciens, 10, Avenue Pierre-Larousse, Malakoff (Seine), France.)

22. American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

22–25. American Dietetic Assoc., annual, Miami, Fla. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

23–25. American Soc. of Body Engineers, Detroit, Mich. (E. W. Lange, ASBE, 100 Farnsworth, Detroit 2.)

24–25. Computer Applications Symp., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

24–25. Engineers General Assembly, New York, N.Y. (Engineers Joint Council, 29 W. 39 St., New York 18.)

24–25. New Mexico Acad. of Science, annual, Albuquerque (W. J. Koster, Dept. of Biology, Univ. of New Mexico, Albuquerque.)

24–26. Acoustical Soc. of America, Ann Arbor, Mich. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

24–27. American Soc. for Aesthetics, annual, Washington, D.C. (T. Munro, Cleveland Museum of Art, Cleveland 6, Ohio.)

24–5. Pan Indian Ocean Science Assoc., 3rd cong., Tananarive, Madagascar. (R. Paulian, Institut de Recherche Scientifique, B.P. 434, Tananarive.)

25–26. Kentucky Acad. of Science, Berea. (G. Levey, Berea College, Berea.)

25–26. Midwest Conf. on Biology Teaching in Colleges and Smaller Universities, Des Moines, Iowa. (L. P. Johnson, Dept. of Biology, Drake Univ., Des Moines 11.)

25–28. American Heart Assoc. Scientific Sessions, Chicago, Ill. (Medical Director, AHA, 44 E. 23 St., New York 10.)

26. American Mathematical Soc., Washington, D.C. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

27–1. Atom Fair, New York, N.Y. (Atomic Industrial Forum, 3 E. 54 St., New York 22.)

28–29. American Cancer Soc., annual scientific session, New York, N.Y. (B. S. Miller, ACS, 521 W. 57 St., New York 19).

28–30. Association of Military Surgeons of the U.S., annual, Washington, D.C. (R. E. Bitner, AMSUS, Suite 718, 1726 Eye St., Washington 6.)

28–31. American Nuclear Soc., 2nd winter, New York, N.Y. (J. Burt, J. M. Mathes, Inc., 260 Madison Ave., New York 16.)

29–31. Entomological Soc. of Canada, annual, Lethbridge, Alta., Canada. (R. H. Wigmore, Science Service Bldg., Carling Ave., Ottawa 3, Ont.)

29–3. Photoperiodism in Plants and Animals, internatl. conf., Gatlinburg, Tenn. (R. Winthrow, Division of Radiation and Organisms, Smithsonian Inst., Washington 25, D.C.)

30–2. American Soc. of Parasitologists, annual, Philadelphia, Pa. (P. E. Thompson, Research Div., Parke, Davis & Co., Detroit 32, Mich.)

30–2. American Soc. of Tropical Medicine and Hygiene, annual, Philadelphia, Pa. (R. B. Hill, 3575 St. Gaudens Rd., Miami 33, Fla.)

30–2. Federation of Paint and Varnish Production Clubs, 35th annual, Philadelphia, Pa. (FPVPC, 121 S. Broad St., Philadelphia 7.)

31. Reactor Safety Conf., New York, N.Y. (Atomic Industrial Forum, 3 E. 54 St., New York 22.)

31–2. Engineering and Scientific Education Conf., Chicago, Ill. (J. E. Harrington, Western Soc. of Engineers, 84 E. Randolph St., Chicago 1.)

31–2. Gerontological Soc., annual, Cleveland, Ohio. (N. W. Shock, Baltimore City Hospitals, Baltimore 24, Md.)

November

2–8. World Metallurgical Cong., 2nd, Chicago, Ill. (W. H. Eisenman, American Soc. for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.)

2–10. Measuring Instruments and Automation, internatl. cong., Düsseldorf, Germany. (Nordwest Deutsche Ausstellungs Gesellschaft, M.B.H., Ehrenhof 4, Düsseldorf.)

3. American College of Dentists, annual, Miami, Fla. (O. W. Brandhorst, 4221 Lindell Blvd., St. Louis 8, Mo.)

3. Society of Vertebrate Paleontology, annual, Philadelphia, Pa. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

3–9. Pan American Cong. of Pharmacy and Biochemistry, 4th, Washington, D.C. (G. Griffenhagen, Smithsonian Institution, Washington 25.)

4–5. Crystal Structure Analysis by IBM 704 Computer, NBS Conf., Washington, D.C. (V. Vand, Pennsylvania State Univ., University Park.)

4–5. Society of Vertebrate Paleontology,

technical sessions, Atlantic City, N.J. (J. T. Gregory, Peabody Museum, Yale Univ., New Haven, Conn.)

4–6. Analytical Chemistry in Nuclear Reactor Technology, Gatlinburg, Tenn. (D. D. Cowen, Oak Ridge National Laboratory, P.O. Box X, Oak Ridge, Tenn.)

4–6. Geological Soc. of America, annual, Atlantic City, N.J. (H. R. Aldrich, GSA, 419 W. 117 St., New York 27.)

4–6. Mineralogical Soc. of America, annual, Atlantic City, N.J. (C. S. Hurlbut, Jr., Dept. of Mineralogy, Harvard Univ., Cambridge 38, Mass.)

4–6. Paleontological Soc., annual, Atlantic City, N.J. (H. B. Whittington, Museum of Comparative Zoology, Harvard Univ., Cambridge 38, Mass.)

4–6. Society of Economic Geologists, annual, Atlantic City, N.J. (H. M. Bannerman, U.S. Geological Survey, Washington 25.)

4–7. American Dental Assoc., annual, Miami, Fla. (H. Hillenbrand, 222 E. Superior St., Chicago 11, Ill.)

6–8. Electronic Techniques in Medicine and Biology, Boston, Mass. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh 22, Pa.)

7–8. Society for Applied Spectroscopy, 12th annual, New York, N.Y. (J. Hansen, 27 Tulsa Ave., Metuchen, N.J.)

7–8. Television and Radio in the Health Field, conf., Chicago, Ill. (American Medical Assoc., 535 N. Dearborn St., Chicago 10.)

7–9. Animal Care Panel, 8th annual, San Francisco, Calif. (R. J. Flynn, ACP, Box 299, Lemont, Ill.)

7–9. Society of Rheology, annual, Princeton, N.J. (W. R. Willets, Titanium Pigment Corp., 99 Hudson St., New York.)

10–13. Society of American Foresters, 57th annual, Syracuse, N.Y. (H. Clepper, SAF, 415 Mills Bldg., Washington 6.)

10–13. Xi Sigma Pi, Syracuse, N. Y. (J. R. Parker, School of Forestry, Univ. of Georgia, Athens.)

10–14. Society of Exploration Geophysicists, 27th annual, Dallas, Tex. (J. C. Hollister, Colorado School of Mines, Golden.)

11–13. Radio Fall Meeting, IRE, Toronto, Ont., Canada. (V. Graham, RETMA, 11 W. 42 St., New York 26.)

11–14. American Petroleum Inst., 37th annual, Chicago, Ill. (API, 50 W. 50 St., New York 20.)

11–15. American Public Health Assoc., 85th annual, Cleveland, Ohio. (R. M. Atwater, APHA, 1790 Broadway, New York 19.)

11–15. American Soc. of Professional Biologists, annual, with American Public Health Assoc., Cleveland, Ohio. (A, F. Borg, Dept. of Bacteriology, Kansas State College, Manhattan.)

13–15. American Meteorological Soc., College Station, Tex. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

13–15. Clinical Chemistry Symp., Cleveland, Ohio. (F. E. Bunts Educational Inst., Cleveland, Clinic Foundation, 2020 E. 93 St., Cleveland 6.)

13–15. Standards, 8th national conf., San Francisco, Calif. (American Standards Assoc., 70 E. 45 St., New York 17.)

13–16. Society of Naval Architects and Marine Engineers, 65th annual, New York. (W. N. Landers, SNAME, 74 Trinity Pl., New York 6.)

14–15. Operations Research Soc. of America, Pittsburgh, Pa. (M. L. Ernst, Box 2176, Potomac Station, Alexandria, Va.)

14–16. American Inst. of Mining, Metallurgical, and Petroleum Engineers, semiannual, Chicago, Ill. (H. N. Appleton, AIME, 29 W. 39 St., New York 18.)

14–16. American Soc. of Refrigerating Engineers, Chicago, Ill. (R. C. Cross, ASRE, 234 Fifth Ave., New York 1.)

17–22. Radiological Soc. of North America, annual, Chicago, Ill. (D. S. Childs, 713 E. Genesee St., Syracuse, N.Y.)

18–21. Magnetism and Magnetic Materials Conf., Washington, D.C. (L. R. Maxwell, U.S. Naval Ordnance Lab., White Oak, Silver Spring, Md.)

18–22. American Soc. of Agronomy, annual, Atlanta, Ga. (L. G. Monthey, ASA, 2702 Monroe St., Madison, Wis.)

18–22. Citrus Virus Diseases Conf., Riverside, Calif. (J. M. Wallace, Dept. of Plant Pathology, Univ. of California, Riverside.)

18–9. Pacific Science Cong., 9th, Bangkok, Thailand. (Pacific Science Board, National Research Council, 2101 Constitution Ave., NW, Washington 25.)

20–24. National Assoc. for Mental Health, annual, Atlantic City, N.J. (NAMH, 10 Columbus Circle, New York 19.)

25–27. American Acad. for Cerebral Palsy, 11th annual, New Orleans, La. (R. R. Rembolt, Iowa Hospital–School State University of Iowa, Iowa City.)

25–27. Physics and Dynamics of Fluids, APS, Bethlehem, Pa. (F. N. Frenkiel, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

28–29. American Physical Soc., St. Louis, Mo. (K. K. Darrow, Columbia Univ., New York 27.)

28–30. Central Assoc. of Science and Mathematics Teachers, 57th annual, Chicago, Ill. (L. Panush, Northeastern High School, Detroit 7, Michigan.)

29–30. American Soc. of Animal Production, annual, Chicago, Ill. (H. H. Stonaker, Animal Husbandry Dept., Colorado State Univ., Fort Collins.)

December

1–6. American Soc. of Mechanical Engineers, annual, New York, N.Y. (C. E. Davies, ASME, 29 W. 39 St., New York 18.)

1–15. Bahamas Medical Conf., 4th, Nassau, Bahamas. (B. L. Frank, 1290 Pine Ave., West, Montreal, Que., Canada.)

2–5. Entomological Soc. of America, annual, Memphis, Tenn. (R. H. Nelson, ESA, 1530 P St., NW; Washington 5.)

4–8. American Psychoanalytic Assoc., New York, N.Y. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

4–10. American Acad. of Optometry, annual, Chicago, Ill. (C. C. Koch, 1506–1508 Foshay Tower, Minneapolis 2, Minn.)

5–7. Texas Acad. of Science, annual, Dallas. (G. C. Parker, Education Dept., Texas A&M College, College Station.)

6–7. Oklahoma Acad. of Science, annual, Enid. (J. T. Self, Dept. of Zoology, Univ. of Oklahoma, Norman.)

7–8. American Acad. of Dental Medicine, New York, N.Y. (S. Ross, 136 E. 36th St., New York 16.)

8–11. American Inst. of Chemical Engineers, annual, Chicago, Ill. (F. J. Van Antwerpen, AIChE, 25 W. 45 St., New York 36.)

9–11. Fluorides Symp., Cincinnati, Ohio. (Secretary, Inst. of Industrial Health, Kettering Laboratory, Eden and Bethesda Aves., Cincinnati 19.)

9–13. Eastern Joint Computer Conf., Washington, D.C. (H. H. Goode, Dept. of Electrical Engr., Univ. of Michigan, Ann Arbor.)

13–14. Association for Research in Nervous and Mental Disease, 37th annual, New York, N.Y. (R. J. Masselink, 700 W. 168 St., New York 32.)

17–19. Nuclear Sizes and Density Distributions Conference, Stanford, Calif. (R. Hofstadter, Stanford Univ., Stanford, Calif.)

19–21. American Physical Soc., Stanford, Calif. (W. A. Nierenberg, Univ. of California, Berkeley 4.)

26–27. Northwest Scientific Assoc., annual, Spokane, Wash. (W. B. Merriam, Geography Dept., State College of Washington, Pullman.)

EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ PROCESS VAPOR FRACTOMETER consists of an analyzer, a programmer and a recorder. The analyzer is installed in the plant, close to the sample take-off point. Column temperature is regulated to ± 0.1°C with a range of 50° to 100°C. The programmer supplies timing, switching, and other electric functions for calibration. From one to four components are directly recorded on a bar-chart representation. Concentration span for each component may be adjusted independently. (Perkin-Elmer Corp., Dept. S587)

■ ROCKING TABLE is a servo-controlled two-axis system for simulating control systems. Angular rotation about each axis is controlled by electric signals supplied to the servo amplifiers. Motions about the two axes are independent. The table measures 16 by 10 in. and has a capacity of 30 lb. Maximum deflection is ± 15 deg, and maximum angular velocity is 120 deg/sec. Response is flat to ± 0.5 db up to a frequency of 1.5 cy/sec. (Short Brothers and Harland Ltd., Dept. S596)

■ WAVEFORM ANALYZER for the frequency range from 0.5 to 2250 cy/sec has a resolution of 0.5 cy/sec. Up to 225 cy/sec, resolution is 0.1 cy/sec. The output of the analyzer is an inked chart record. Six scan ranges from 2 to 500 cy/sec may be centered at almost any point in the range. Resolution is adjustable in steps to 20 cy/sec. (Panoramic Radio Products Inc., Dept. S597)

■ PHASE SHIFTER for thyratron control applies alternating current to the thyratron grid and varies its phase angle over 180° to control thyratron output up to 10 kw. Four isolated control windings are provided for d-c input signals. Input signal power requirement is 1 mw. Signal voltage for full control may be 0 to 1 v or 0 to 2.5 v, depending on the model. (Vectrol Engineering Inc., Dept. S599)

■ MOISTURE ANALYZER is an application of nuclear magnetic resonance technique for detecting protons. The instrument will detect hydrogenous liquids in solid material. Tightness of binding of the water or other hydrogenous liquid may be estimated by more detailed examination of the magnetic resonance spectrum. The sample to be measured is placed in the uniform magnetic field of a perma-

nent magnet with a 10-in. pole face and a 2-in. gap. The magnetic field is varied by sweep coils wound on the poles. At a particular field strength characteristic of the proton, the sample will absorb energy from a radio-frequency field established by a coil surrounding the sample. The derivative of the absorption curve thus obtained is recorded. By measuring the derivative of absorption in this manner, the instrument is able to distinguish the narrow absorption bands, characteristic of protons in fluids, from the broader absorption produced by protons in the solid in which the liquid is contained. Precision of the instrument is ± 0.1 percent. (Schlumberger Well Surveying Corp., Dept. S600)

■ TIME-INTERVAL METER provides for measurement of elapsed time in the range of 3 μsec to 1 sec with accuracy of 1 μsec. Extension to 10 or 100,000 sec is optional. The time interval is defined by voltage signals which may range from − 300 to + 300 v. Trigger sensitivity is 0.2 v root-mean-square at any voltage level within that range. (Computer-Measurements Corp., Dept. S601)

■ VOICE DATA LINK converts automatic commands from computing machines into verbal messages. The system consists of recorded-word storage, word-sequence control, programmed sampler, and input-control units. A prerecorded library of words can be provided for adapting the system to a particular operation. Simultaneous transmission of more than one message over individual audio channels can be accomplished. (Fairchild Camera and Instrument Corp., Dept. S603)

■ MICRO KJELDAHL DIGESTOR incorporates six 200-w heaters for operation at temperatures up to 450°C. Flasks from 10- to 100-ml capacity and test tubes up to 12 in. long can be accommodated. (Arthur H. Thomas Co., Dept. S612)

■ ELECTRONIC GAGE has four magnifications from 400/1 to 20,000/1. Gaging is based on comparison to gage blocks. A self-calibrating feature permits check of the full-scale reading without reference to masters. Readings are repeatable to 1 μin. (Taft-Pierce Manufacturing Co., Dept. S636)

■ VAPOR-PHASE CHROMATOGRAPH for operating temperatures from 20° to 100°C is a portable desk model. Columns up to approximately 30 ft long are accommodated. The detector is of the thermistor type. Sampling systems for liquids or gases are interchangeable. A 10-mv recording potentiometer for output is optional. (Podbielniak, Inc., Dept. S639)

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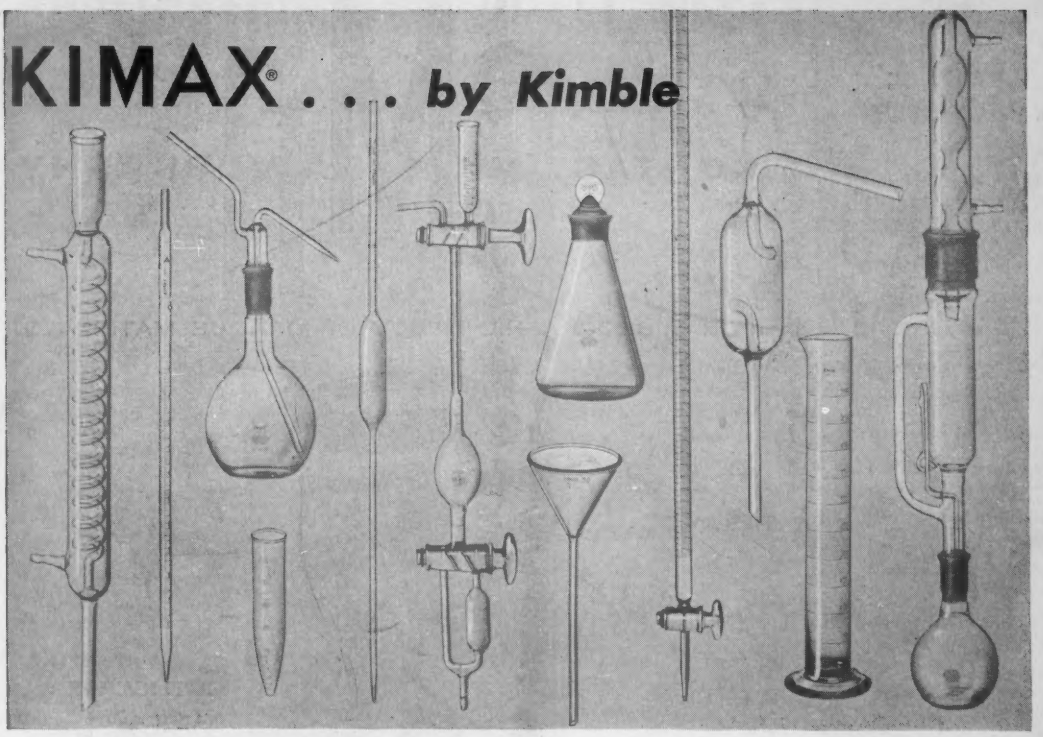

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